

THE EAST AFRICAN AGRICULTURAL JOURNAL



of
KENYA
TANGANYIKA
UGANDA AND
ZANZIBAR

IN THIS ISSUE:

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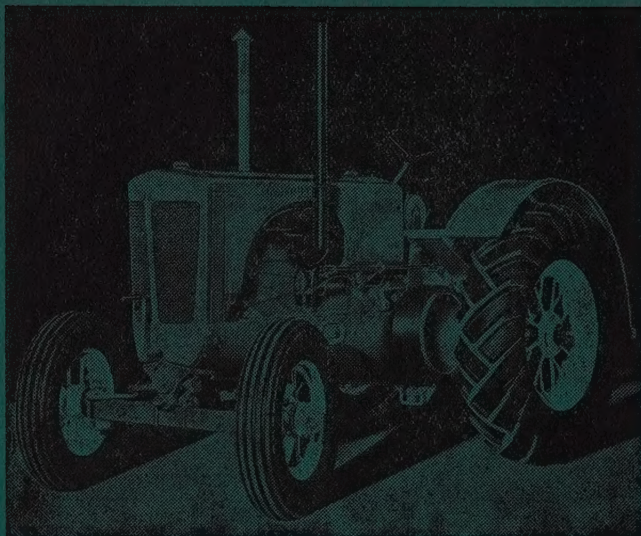
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JULY
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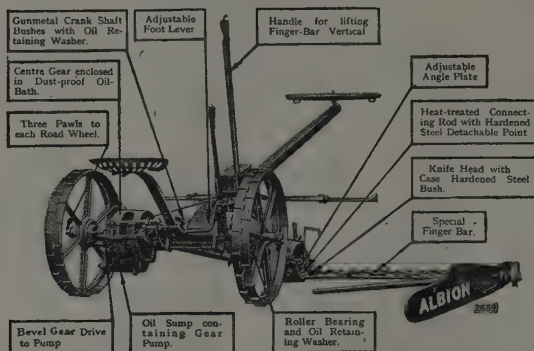
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Matter submitted for publication should preferably be sent through the local member of the Editorial Board. Manuscripts should conform with the recommendations contained in *Notes for Authors*, which may be obtained from the Government Printer, Nairobi, or from a member of the Editorial Board.

Twenty-five separates of original articles will be sent free to authors. Additional copies can be supplied on payment if application is made at the time the manuscript is submitted.

Readers are reminded that all agricultural inquiries, whether they relate to articles in the Journal or not, should be addressed to the local Director of Agriculture, and not to Amani.

SETTLEMENT

In the past much of the settlement in Kenya Colony has been on plantation lines; that is to say, the activities of the settlers have mainly been devoted to one crop (coffee, maize or wheat), whilst some have gone in purely for cattle, usually on a ranching basis. Except in certain cases and under very favourable conditions, this kind of farming has been unable to withstand market fluctuations, and the farmer has suffered from his entire dependence on the price of one product on the world's markets. Many settlers also, having come out originally only to do planting, have been handicapped by lack of knowledge of real farming and of what is the best kind of farming for the country. Last, but not

least, the agricultural industry has suffered from the fact that Kenya was largely developed during a boom period, when prices of both land and materials were inordinately high; and the subsequent debt caused by these early high prices has been extremely burdensome.

When the need for closer settlement of the country became apparent, the Committee which was appointed to consider ways and means of increasing settlement took all these and many other factors into consideration in formulating their report, which therefore contains many proposals for safeguarding the prospects of new farmers and for providing, where possible, similar assistance for existing farmers.

The agricultural industry of Kenya is largely dependent on an overseas market,

with all the expenditure which this involves in transport costs, and all the time it has to face the competition of countries sometimes more favourably situated. A low price-level has far-reaching effects, since to obtain a living out of the land, it is necessary in any country to have a minimum turnover. If a high priced local market is available, the amount of produce which will give this turnover can be small, but where prices, as in Kenya, are on the low side, the output has to be correspondingly larger. This means that the acreage needed to produce the required turnover will be greater in Kenya than in, say, European countries, which have a large local market.

In the first place therefore, the smallest farm must be comparatively large, but another factor which has a bearing on the acreage of land desirable is the quality of the soil and the climatic conditions, both of which vary from district to district. In some parts, 1,000 acres or more is needed to give the turnover; in others, as little as 300 acres may be enough. The price paid for the land is therefore of great importance. For example, if 1,000 acres were necessary to produce the requisite turnover, and £5 an acre were paid for it, the capital spent on land alone would be £5,000, which would mean that the farm would have to carry an interest charge of not less than £300 a year. This would be ruinous. If, however, a farm of 300 acres could produce a similar turnover, £5 an acre might be quite a reasonable price. The comparable price for a farm which had to be not less than 1,000 acres would Sh. 25 to Sh. 30 an acre. Interest charges on the capital invested in land, stock, etc., must not be so much as will jeopardize the farmer's existence during the first four or five years of the development period. This is well brought out in the schedules attached to Section V of the Report. Well

stocked and developed farms with good buildings on them are quite a different proposition as regards value, but for a totally undeveloped farm the money available should be spent in development and not frozen in mere land, which is worth very little till it is developed.

The Report recommends that Government should, by means of a loan of £250,000 or more, advance 90 per cent of the land purchase price, repayable over a period of fifty years, and, in order to keep the price of land within reasonable bounds, the Committee has also recommended that Government should not make these advances except for land which is priced at a value not higher than it is considered the farmer will be able to pay fairly easily out of the net income from his farm; and the farm itself must be inspected and proved as a workable proposition before it is bought. This is one of the most important features of the Report, and is the basis of the scheme for assisted settlement. These advances for purchase of farms are, in effect, the institution of a tenancy system.

It is also strongly recommended that arrangements be made for farmers who receive assistance from Government to be looked after and advised by district agricultural officers and by local bodies of farmers qualified to give advice. This should prevent foolish mistakes being made by newcomers, and is a means of providing them with the invaluable experience which has been gained, often at great cost, by the farming pioneers. It is also recommended that new settlement, wherever the district is suitable, should be on a mixed farming basis of stock and crops, and each branch should be as diversified as possible. For example, the live stock should be cattle and pigs, probably poultry as well, and sometimes sheep. The crops should include fodder crops and concentrates for the live stock,

together with, if possible, several cereals, flax, pyrethrum, sometimes coffee, and so forth, so that the farmer's risks may be spread amongst as many activities as possible and his labour well distributed.

Before closer settlement can become a reality, it is essential to provide adequate water supplies. There are not enough rivers and streams for every farm to have one on its boundaries, and recommendations have therefore been made to provide assistance for finding water by boring, and for making dams.

One of the most serious handicaps that a farmer has to face in Kenya is the existence of stock diseases. Recommendations have therefore been made with a view to eradicating rinderpest in order that beef may be readily marketed in Great Britain. A disease even more costly to the farmer is east coast fever. Most of the country is "dirty," and the conclusions of the Settlement Report show that this must not only postpone the farmer's profits from cattle for at least a year whilst he is cleaning up, but also set back his profits from pigs by a similar period, and increase his cost of living for the first year. The position is further complicated by the almost universal practice of keeping squatter labour, who are allowed to have their susceptible stock with them. This keeps the farms dirty, and it will be essential for every farmer either to fence off his squatters, or (and this is infinitely preferable) to get rid of all squatter cattle. If every district united to do this, there would be no difficulty in keeping squatter or residential labour so long as they were given a small acreage to cultivate and possibly milk or skim milk from the farmer's own herd. Farmers are getting together in this matter, but a bigger drive yet is needed. "Clean" land is clearly worth a good deal more than "dirty" land.

Another important proposal is in connexion with agricultural education. The

pupilage system is to be improved, and it is hoped that a training farm may come into being. This should be of great assistance in helping young people to get on to the land, either as owner-farmers, or at first as managers who will later be able to begin farming on their savings. Parents, particularly from abroad, who might be doubtful of sending their boys out to be pupils on private farms thousands of miles from home, would probably not hesitate to send them to a farm run under the auspices of Government.

So much for the problems of the agricultural industry in Kenya and the main proposals for overcoming them, and they are perhaps more easy of solution than those of many other countries.

Kenya possesses, however, distinct advantages. An equable climate without the rigours of a winter period will be an attraction to any farmer, however hardened he may be. An income of between £300 and £500 a year after the development period, on an expenditure of about £3,000, of which one-third at least would be advanced by Government, is not to be sneezed at, especially if earned under the pleasant conditions which are to be found in Kenya. Under certain circumstances the expenditure can be reduced to £1,250 exclusive of the Government grant, and half of this sum could be found out of savings if the prospective farmer were prepared to work as a manager for six or seven years. Indeed, if the right opportunities are seized, such as occur from time to time, it is not impossible for a resident to start in a small way on a capital of £500. The possibilities are endless, but the essentials are an appreciation of the proper policy for the farm in whatever district it may be (and it will vary according to the district); a clear idea as to the proper way to set about implementing it; a workable farm, with water, able to respond adequately to

what is put into it: a hardworking farmer who loves the life and understands all the branches of his profession; a maximum spent economically on development and a minimum on land; a sympathetic Government doing all it can to help the farmer, both in the detail of his work and in safeguarding his interests by suitable legislation and the control of crop and stock diseases; an existing farming community full of experience and able and willing to pass it on to newcomers; and last, but not least, a commercial community whose interests are identical with those of the farmers whose needs they provide for. All these things are to hand. They merely need bringing together, and, if that is done, Kenya cannot fail to progress along the path of prosperity on which we are all stepping out with hope in our hearts.

G.J.L.B.

LIFE AT HIGH ANGLES

It is now generally recognized that soil behaves like Sir Isaac Newton's apples and will tend to assume a relatively lower position if left unsupported in a relatively higher one. Such has been the astonishment of our generation at this discovery that we already wonder if the figures for tonnage of good soil wasted from mismanaged lands will not shortly be exceeded by those for acreage of fair white paper devastated by zealots for soil conservation. We fully believe, however, that less soil would have been saved if more paper had been spared. Some, at least, of the vast output of anti-erosion literature is read with profit, and some, at least, of the soil is retarded on its downhill trend. Even if it came to ton for ton (which God forbid!), soil would be a good swap for paper, which after all is only carbohydrate and can be had in unlimited quantities.

Those of us who wander at times in these printed wastes, and equally those who have travelled amongst the actualities

of soil erosion and of efforts to stem it in other lands, would agree that comparatively little of the literature, or of the effort either, is devoted to the problem as it arises on really severe slopes. This is manifested in the way the jargon of the subject has developed. If you, an enthusiastic conservationist (what a word, Bobby!) detailed to me the procedure you would suggest on a moderate slope of so much per cent, you would rightly feel injured if I inquired innocently whether you were meaning sines or tangents. Rightly, because for slopes up to about twenty degrees it doesn't matter, the distinction is not a practical one, and it makes no appreciable difference in any setting out of works in the field. For the twenty-degree slope, on the one basis your gradient is 34 per cent or 1 in 2.9; on the other it is 36 per cent or 1 in 2.75. For slopes less than this the small difference almost vanishes. And as almost the whole body of soil conservation practice, or at least that which has been most written about, has had to do with the treatment of ground not usually so steep as 20 degrees, you purr away happily in per cents with never a thought.

Actually you are talking in tangents. Now consider a slope of thirty degrees. The figure begins to mount: $\tan 30^\circ$ is 0.5774 or about 58 per cent. Tilt your hillside to forty-five degrees, and you have 100 per cent. If you had been meaning sines, this would be a sheer cliff, and even in tangents it *seems* like one; you have to reach for handholds to haul yourself up it. Yet in hill districts in East Africa there are slopes of not far short of 100 per cent in arable cultivation. The present writer (watch T.W.K. bite on this a column or two further on!) has himself measured a 42-degree slope (90 per cent) on a finger millet field in the western foothills of Mount Elgon; he came near to doing the same in Kigezi, and could be pretty sure of matching these examples in

Tukuyu, in Old Moshi, in Usambara, or in the territories of most of our hill tribes. The standard thing to say about such slopes, if we follow the literature, is, as Mr. Maher points out in his article "Hill Culture" in this issue, "retire them from cultivation, put them into trees, have done with disturbance of the soil and let them re-vegetate lest worse befall you." Yet when *all* the land of a people falls into classes of slope that are considered as too steep for tillage, retirement from cultivation means nothing less than evacuation, unless the basis of subsistence of the people is altered fundamentally. If they are to continue to grow their own grain and beans, there is no other land for them to use than that which slopes too steeply for safe permanent cultivation. Palliative measures which work well on less severe gradients are of poor effectiveness here and the problem baffles solution.

In a situation of apparent defeat like this, one must cast around for some quite different line of approach, and in this case the hint is given in the qualifying phrase used above, "... unless the basis of subsistence of the people is altered fundamentally." Is there any real reason why hill folk should continue to be grain farmers when their brethren of the plains and alluvial bottoms can take over that function without wasteful expenditure of soil? Every agricultural people no doubt has to evolve through a phase when difficulty of communication, personal insecurity and intertribal distrust compels small communities, even family groups, to be self-contained and provide by their own labour almost the whole range of necessities. It was so in rural England in the days of open-field farming; there were no specialists, there was little exchange of commodities of any kind and none of

staple foodstuffs. Most African tribes are still in the corresponding stage of would-be self-sufficiency, but their system cannot be countenanced indefinitely when it leads (just as it was doing in the days of overstocked commons and overcropped wheat lands in pre-enclosure days in England) to ruination of the soil. It is time to introduce a little specialization, a better adaptation of crop to land, perhaps also individual tenure and enclosure of pasturage.

It is with an interpretation such as this that one should read Mr. Maher's article. Its argument is that if you live in the hills you should avoid annual crops as far as possible and make your living by means of trees, shrubs and perennial herbs, which will require much less soil disturbance to maintain them in production. Eat what you can of the produce, feed your stock by "soiling" with cut forage, and exchange all sorts of tree products for grains and pulses through the channels of trade. Of the many plants he suggests for trial in such a programme there are lots that seem improbable candidates, but it is early days yet in plant introduction, adaptation and acclimatization into tropical hill country. There is plenty of scope and some likely winners are sure to be waiting. To revert again to my analogy with English agriculture of not so very long ago, read this about common garden vegetables in the year 1651: "Some old men in Surrey, where the Art of Gardening flourisheth very much at present, report, that they knew the first Gardiners that came into those parts to plant Cabbages, Colleflowers, and to sowe Turneps, Carrets, and Parsnips, and to sowe early Pease, all of which at that time were great rarities, we having few, or none in England, but what came from Holland and Flaunders!" The same writer¹ knew of many places where "a

¹ Robert Child, quoted from Lord Ernle's *English Farming Past and Present*. The new edition of his book, by Sir Daniel Hall (recently published by Longman's at 15/-) would be browsed in with interest by many readers of this Journal.

few Gardinèrs might have saved the lives of many poor people, who have starved these dear years." Just as among African peasants *now*, the crops familiar to English peasants *then* were too few. Starvation of man and beast is still a common enough African phenomenon in "dear years"; here we have the germ of a policy towards reducing it to the status of something that used to happen in history.

Read also, as an account of solid progress already made along these same lines of increased variety of cropping, combined with better adaptation of cultivation methods to soil and slope, Mr. Chaundy's article on his work with the West Suk tribe.

G. M.

"IN THE OPINION OF THE PRESENT WRITER"

Modesty, in authors as in children, is commendable. Clumsy writing may be forgiven a child, but not an author of mature years. When modesty appears to necessitate clumsy writing, a semblance of immodesty (which, in fact, will be noticed by nobody except the author) is preferable to periphrasis.

I refer to the apparent horror with which nearly all contributors to this Journal, and indeed to other similar publications, regard the use of the personal pronoun. This horror is no doubt largely due to the curious and peculiarly English custom of writing the first person singular of the personal pronoun with a capital letter.

I do not wish to suggest that the Government Printer should be required to increase his stock of capital "I"s, for there are many papers that can be, and are, written in a purely objective style. But where a writer is describing his own experiments or stating his own beliefs, an

occasional "I" is far preferable to any of the various methods of avoiding it, such as the one at the head of this note. And there are two even worse ways of escape. One is the use of the passive, e.g., "it is believed" or "it has been discovered"; for this, more often than not, is ambiguous. If the writer means, as he usually does, "I believe" or "I discovered", let him say so and not be ashamed of it. If he really is referring to the beliefs or discoveries of others, let him make the fact clear. The other is the use of what Fowler¹ calls the "false first-personal 'one'". This example of bad grammar has, one fears, become increasingly common of late; one has noticed it recently in this Journal. (Observe that in the foregoing sentence the first "one" is legitimate; it is an impersonal pronoun including anyone else who is interested in grammar. The second is incorrect; it is merely a substitute for "I" and, as Fowler says, is "a new invention of the self-conscious journalist.")

Let me conclude with a true account of a conversation on this subject that I held many years ago with a Mr. H., then Director of Agriculture of one of the East African territories. I give it in "impersonalese" in order to emphasize the clumsiness of this style.

Mr. H. did not agree with the present writer's opinion and said that he, Mr. H., would under no circumstances use the word "I" in a scientific article, though he admitted that, to avoid repeated circumlocutions, he sometimes used the plural "we". To which the present writer replied that he was sorry to hear that Mr. H. had a tape-worm. For, continued the former, it is only Royalty, writers of editorial leaders, and people suffering from helminthic infestation, who have the right to use the plural "we".

T. W. K.

¹ Author of *Modern English Usage* (Oxford, Clarendon Press, 7/6) and other lively works on the writing of the English language.

SETTLEMENT COMMITTEE REPORT*

A CRITICAL REVIEW

By G. R. Morrison, Nakuru, Kenya Colony

The recommendations of the Settlement Committee, formed as a result of Major Cavendish-Bentinck's motion in Legislative Council, are the first concrete proposals for attracting newcomers to the European Highlands since the Soldier Settlement Scheme, and go very much further than the latter. As this is a review and not a résumé, it must be assumed that the Report has been read, as indeed it should be by anyone who professes to be interested in the development of the Colony.

It must be realized at the outset that the Report is for the information of Government. It is to be hoped that it will not be used as propaganda for settlement in Kenya, because it takes a knowledge of Kenya's attractions almost for granted. This is quite natural in a report to the local Government, but one paragraph could never suffice to give a true picture of the pleasing features of life in Kenya to those who are unacquainted with the Colony.

Farming is scarcely an occupation for fortune-seekers, though pyrethrum growing in the best districts may well be the best speculation in agriculture to-day. As the Report states, the prospects of farming in Kenya compare favourably with those in any part of the Empire. But Kenya's greatest claim to attention is that, in addition to a financial return at least as good as her competitors can offer, farm life in the Colony is far more pleasant and enjoyable and money goes further.

During the compilation of the Report the Committee lost Mr. Hosking, and

Mr. Mortimer went from the bottom of the list as Secretary to the top as Chairman. No fewer than five members of the Committee left the Colony for varying periods. The Committee was a strong one, but one cannot help feeling that one member who had developed the type of farm which obviously would have to be recommended, i.e. the small mixed farm without plantation crops, and was running it for a living at the present time, would have been of assistance.

The Report is rightly comprehensive, and apart from the introduction and the summary is divided into eight sections. Those devoted to water supplies and agricultural education, both of which are elaborated in the appendix, are particularly interesting. Brave Mr. Burton adds a note on a scheme for an undeveloped land tax. Such a measure is said to be premature in the main Report, although in another section the view is expressed that on leasehold farms, the development conditions of which have not been fulfilled, "pressure should be brought to bear on holders either to develop their holdings or to dispose of them at reasonable prices." It would be a pity if such measures were delayed until harm had been done by the withholding of land from the market.

But the main interest in the Report must be the actual schemes of farming for which costs and hypothetical accounts are given in the schedules. Their formation must have been a very difficult matter for many reasons. Evidence from farmers of so many different types and such varied

* *Settlement Committee Report*, Government Printer, Nairobi, 1939, price Sh. 2/50.

experience must necessarily have been conflicting. The schemes must therefore be taken as applying to the average man who is prepared to work averagely hard and demands an averagely comfortable living. It is safe to say that had similar caution been exercised by the post-war settlers (in far more difficult times when costs were higher, markets less certain and knowledge far more restricted), Kenya's present stage of development would not have been reached. In those days, cars were the exception rather than the rule, few houses cost anything like the allowances now suggested, and cheaper standards of living were frequently accepted. And it may be said that the settlers of that time did not suffer therefrom.

Not only may it be accepted that in most respects the schemes are on the conservative side, but the omission of side-lines such as pigs and poultry provides an additional margin. The difficulty of including them can be well understood, but it should also be clearly realized that most of those who have attempted to develop farms on a minimum of capital have relied on such side-lines to a very considerable extent, as not only do they bring in money month by month but they are also less dependent on weather conditions than the main schemes.

The Committee were right in assuming that the land would be dirty from the point of view of east coast fever, as most of the land available would be so, especially at the price estimated. It may be mentioned here that in the description of districts in the appendix, Subukia is wrongly stated to be "dirty". The fact remains, however, that the bulk of farming land for the schemes would be dirty, deplorable though it may be. It will be remembered that in Col. Hoy's report, which was made ten years ago, and part

of which is included in the volume, the following paragraph appears:—

"From investigations made I feel that the present incidence of stock diseases and scab in the Colony are most inimical to comprehensive land settlement. At present the risk to those who invest money in stock of any kind is too great to induce stock farmers to settle here. It is true that native stock can be kept with some success, although the natural increase is small, but if the Colony is ever to export cattle or mutton sheep grading-up is essential and this cannot be done at present without undue risk. I consider that no land but that in clean areas should be alienated at present for mixed farming settlement. Looking at the matter from a practical standpoint, I think that in order to prepare more land for settlers suitable large blocks of country should be ring-fenced and compulsory and universal dipping enforced within such areas. Effective stock movement restrictions should also be enforced so as to remove the danger of reinfection from tick-borne diseases. These areas could be increased as financial resources allowed and land is required for settlers."

It is a sad reflection that no such measures have been taken. The present Report states that:—

"It is reassuring to see that the Cattle Cleansing Ordinance of 1929, which was designed for this purpose, is gradually being adopted by the mixed farming districts. We feel that it is impossible to over-emphasize the importance of compulsory cattle cleansing in any attempt to increase settlement of the mixed farming type."

The newly arrived settler might feel less reassured to find that the only district which has accepted the Ordinance has not yet had the Act applied, though the statutory meeting was held nearly three years ago, and that other districts have only after two years' delay managed to persuade Government to hold the statutory meeting. This point cannot be too clearly stressed, since the delay of a year in getting the dairy herd on to the farm does not mean only the postponement of the cream cheque: the side-lines previously referred to depend to a great extent on skim milk.

There are other instances of extraordinary delay in action. For example:—

"We wish to draw the attention of Government to the harmful effect of continued delay in putting the Resident Labourers Ordinance, 1937, into operation."

And—

"In 1927 a scheme was adopted by the Legislative Council for the provision of special facilities for grants of farms or residential plots to encourage Government and Railway officials to retire in the Colony. The scheme was absorbed into the Closer Settlement Proposals, 1928, but was never brought into operation."

Another example is the history of the movement for the freeholding of land—a subject which has been under consideration for seventeen years. The Chairman, in view of his official position, was unable to express an opinion on this matter; the Committee adds:—

"We make no recommendation on the subject, however, as we understand that Government has undertaken to appoint a committee to inquire into these subjects. As long ago as 1922 the Land Tenure Commission recommended the freeholding of land titles; in 1932 an assurance was given by Government that an inquiry would take place and that assurance has been renewed on subsequent occasions."

Surely everyone must wish that these proposals for further settlement, if passed by Legislative Council, should be given the best chance, and there is no doubt that a final decision on these outstanding matters would help. Some may feel that that will be the acid test of sincerity.

The suggestion that Government should finance schemes up to half the value of the whole expenditure is most valuable. It is arguable that the security would be quite as good, if not better, than merely that of the land. Moreover, it would imply some Government control of the farming operations, which might well result in a number of model farms springing up all over the Colony.

The fact that the assistance will be available for men already in the country

should have the effect of enabling present farm managers who are efficient to start on their own; and surely these would be the most likely to succeed. It would also raise the status of the manager, who compared with current salary levels is in many cases underpaid.

A report of this kind must be concise, and probably the compiler regretted the exclusion of much interesting matter as much as the reader will. For example, it would be interesting to see the capital required for settlement in Kenya compared with that needed in other countries, including England. And when the schemes are put before prospective settlers, it might be useful if the proportion of capital expenditure on realizable assets was shown in each case.

A great deal of discussion must obviously have taken place on the cost of living. A paragraph in a minority report signed by Mr. Theron Focks and Major Cavendish-Bentinck will find an echo in the minds of many farmers. It reads:—

"We consider that the standard of living in Kenya, as compared with that of other agricultural countries, is on the average too high, and that the type of person to whom we refer could work harder and live harder than is general in Kenya. A man born on the land, and of working farmer stock, is born with something in his make-up that can never be acquired by experience or teaching. Such people, we are convinced, would eventually be successful, would make really good citizens, and would prove an invaluable asset to the Colony. We therefore feel that every encouragement should be given to them."

But it must be realized that the standard of living on which the farmer can live happily must depend to some extent on that which prevails in the country generally. The wealthier section of the community could do much to make social life less expensive.

One can only hope that the recommendations of this Committee will not be allowed to drop like those of so many

of its predecessors. The Report has perhaps done more to bring the squatter stock problem to the fore than anything previously. It seems a pity that before a committee is disbanded one or two of their number are not appointed to follow up the recommendations and insist on some answers being given. The matter of agricultural education, for example, is of immediate importance. If there were any immediate response to the proposals, it would be hard to find farms on which any number of pupils could be trained. It is essential that newcomers be trained not only in the latest methods but also with the latest equipment. And many of

our most efficient farms to-day have not the benefit of really up-to-date machinery.

Too much importance cannot be attached to the launching of this scheme, and to preparations for it. Much will depend on how satisfied the first-of the new settlers may be. It will be too late to correct mistakes after they have gone. Mr. Burton's fear of land prices rising is probably only too well founded. The enormous delays previously referred to may cause the newcomer some misgivings.

The Report has laid a sound foundation. All sections of the community can assist in the work of building up the best possible organization.

THE BUILDING OF SOD BANKS

The following is a method in use in Northern Ireland and recommended by the Ministry of Agriculture there. Inquiries on the subject having been received from Kenya, it is re-printed for general information.

The procedure in erecting sod banks varies considerably in different parts of the country, but the following method is in fairly general use:

The turf covering the site on which the bank is to be built is to be cut into sods about 12 inches long and 9 inches wide and about 6 inches thick. The usual width of a bank is 4 feet at the base, sloped to from 2 to 2½ feet at the top. The site should be cleared of sods to the extent of at least 2 feet on each side of the actual area on which the bank will be built. This width will depend on the height of the bank, as the higher it is the more material will be required and the wider the dykes that will be necessary from which to obtain the filling. The soil on the site is then loosened up and two rows of sods are laid on their edges at the necessary width apart, with grassy

side outwards, to form the outside of the bank. These sods should be laid in the same order in which they were dug. The cavity between them is then filled to the top of the sods with loose soil from outside and the complete layer is made as firm as possible. The next row of sods is laid on the flat with the grassy side downwards, so that the edges are level with the grassy side of the row of sods placed on their edges. On top of these are placed further sods on their edges as was done with the first row, and the bank is completed with rows of sods placed alternately on their edges and on their faces. The top of the bank may be finished by rounding it off with thin sods well beaten down with the back of a spade or with heavy retentive clay, if available, which can be made to stick closely by beating.

The secret of building good sod banks is to cut the sods carefully so that the joints can be beaten into position to prevent air reaching the roots of the grass.

PROFITS FROM A FARM IN KENYA*

By C. T. Todd, Timau, Kenya Colony

Most of the land at the higher altitudes in Kenya (7,000 to 9,500 feet), where there is an adequate water supply, a good average rainfall (from 28 in. a year well distributed), sufficient timber for farm buildings, fencing and firewood, and good soil, is suitable for small farms, where the practice of mixed farming, with dairying as the principal object, could be undertaken.

Under a closer settlement scheme, the acreage of farms would be between 300 and 600, the size being dependent on the type of land available and the financial position and experience in farming of the applicant.

The amount of land left at the disposal of the Government at present is strictly limited. But, if the terms of the leases under which the great majority of farms are held in Kenya, are strictly enforced, the acreage available for closer settlement will be greatly increased. Land which has been lying idle will come into the market and become available to those who are prepared to make the best use of it.

The newcomer to Kenya who has no previous experience of practical farming would be well advised to apprentice himself for one year to an established farmer of repute, in order to become thoroughly conversant with local methods of husbandry, the handling of native labour, and the language, as spoken by the farm labourer up-country. The cost of such apprenticeship would be in the neighbourhood of £100. For one who has had practical experience the period of apprenticeship might be reduced to six months.

When considering a scheme for closer settlement it is reasonable to assume that

the supervision of labour by the working farmer, with a small labour force, will be more efficient than on a large estate where the labour force would be considerable in proportion to the amount of European supervision available. On the small farm it should be possible for the owner to maintain a comparatively small labour force, as he will be working with his labourers, who will thus be under constant supervision. By such means the labour will be used to its fullest economic extent. Also, the working farmer with a small acreage would probably fence off his lands into paddocks for grazing and agriculture, using machinery in place of natives wherever such use is consistent with economic efficiency.

The permanent labour force on a small mixed farm, where pyrethrum is not a main crop, might be six, with an increase during harvest time. The number required during the first sixteen months of development would probably be fifteen.

Kenya is not a country to which a man should come without adequate capital to start farming on his own. The cost of beginning on a farming venture, for the newcomer without practical experience, would be: pupilage for one year, £100 (for a newcomer with practical experience, £50); farm machinery, £150; team of 14 grade oxen, £56; dwelling house, £100-£150; outbuildings, £30; furniture, £50; seed for 25 acres, £7; 30 cows close at profit at £12 per head, £360; one pure-bred bull, £40; 25 ewes and one ram, £25; poultry, £20; living expenses for a man, wife and child for the first sixteen months, £160; labour wages and rations for 15 boys for the first sixteen months, £130; fencing, £70; reserve, £300; other items,

* Reprinted, with partial revision, from *The Crown Colonist*, October, 1938.

£70, making a total of £1,718. In addition, there would be the cost of passages out to Kenya, and cost of land. If the land is bought from Government, the usual rule is one-tenth of the purchase price as a deposit, and the balance paid in equal instalments over ten years, the land being held on a 999-year lease at a rental of 20 cents an acre, subject to revision. The price of land would probably vary from 10s. to 20s. per acre for undeveloped land. There is a possibility that some farms will be run on a group scheme, in which event there would probably be a general pool for implements, stud bulls, rams, etc. Under such a scheme the capital required would be considerably less.

Having looked at the debit side of the ledger, a view of the credit side may be taken. On the first year, after deducting a total of £425 to cover living expenses (£120), labour (£130), running expenses (£80), and depreciation (£95), the balance would be £81 on the debit side of the ledger, assuming that the returns for the year's work were as follows: From five acres of pyrethrum, £30; 25 acres of wheat, barley or oats, etc., yielding 192 bags and showing a return of 12s. per bag, £115 4s.; eggs and dairy produce, with butterfat at 80 cents per lb., £172; increase in stock, £22. At the end of the second year, when the production capacity of the previous year's arable land has been improved by working and the acreage under crops increased, the farm would show a net profit of £93. After the fourth year (by which time the

live stock bred on the farm will be producing, some 30 acres of grazing will have been planted with improved grasses and the existing grassland improved by intensive grazing, manuring and harrowing, and more land have been put under the plough), the farmer's net profit, after deductions have been made for depreciation on buildings, implements, breeding stock, etc., should be in the neighbourhood of £300.

AFTER FIVE YEARS

By the fifth year he should be in an established position and the prospect of drought or locusts should not be of serious consequence, as he would have sufficient reserves of foodstuffs in the form of hay, ensilage and concentrates to cover such a situation.

Having mentioned drought, it should be explained that there is hardly a month in the year when some rain does not fall. The rainfall during a drought year, in a district where the average rainfall is 28 inches, is not likely to be less than 20 inches. Locust invasions are rare, though it is as well to have a reserve of food.

It should be possible, on suitable land, to make an average income of £600 to £800 a year, once the farm has reached full production, allowing normal prices for farm produce. Although a fortune is not likely to be made from farming in Kenya, there is every prospect of a comfortable living in an ideal climate, in a country where sport is cheap and it is possible to obtain leisure in which to enjoy the vigorous kind of life which Kenya has to offer.

THE MAINTENANCE OF FERTILITY ON TOBACCO ESTATES IN NORTH-EASTERN RHODESIA

By R. H. Fraser, B.Sc., A.I.C.T.A., Agricultural Officer, Northern Rhodesia

One of the principal objects of the Fort Jameson Agricultural Station has been to discover some method of crop rotation and soil management whereby the productivity of the tobacco estates in North-Eastern Rhodesia may be maintained indefinitely and the wasteful process of continually clearing new land eliminated. To this end, experiments were designed and first put into operation in the planting season of 1931-32. Some of these were concluded in 1937, others are still in progress. Meantime, in order to minimize time lost in waiting for the experiments to mature, the writer published an article describing a rotation which, on theoretical grounds, should be suited to the district and its only cash crop—tobacco. [1] This rotation consisted of planting tobacco, with fertilizer, for two years, followed successively by sunn hemp and maize, after which the four-course cycle was repeated. Tobacco is a crop which offers peculiar difficulties to precise experimentation, because quality, quantity and disease have to be taken into account. Also the element of human error is a considerable factor in the picking, curing and grading. Monetary value of the crop is not a constant item, since much depends on the individual buyers and on market fluctuations. In view of these difficulties, constant observation plays a major part in assessing any tobacco experiments, and while a careful record of all yields has been kept, for these reasons it is not proposed to illustrate this article with the full experimental data gained

during the past seven years. The opinions expressed are, however, essentially based on these records, supplemented by personal observation. The soil on which the experiments were conducted is a deep chocolate to red loam, of a type generally used in the district for the production of flue-cured tobacco, but which would be regarded more as a maize or dark-fired tobacco soil in Southern Rhodesia or Nyasaland.

LAY-OUT

Four fields, designated respectively A, B, C and E, were planted under different treatments as follows:—

Field A.—Had been a native garden for four years before it was used for experimental purposes. It consists of four blocks, each of three acres, under a rotation of tobacco (f),¹ tobacco (f), sunn hemp; followed by maize. In addition, two tons per acre of well rotted kraal manure were applied each year in April to alternate halves of the field and immediately ploughed under.

At first the sunn hemp was ploughed under, but latterly the stems have been cut and made into compost, which was then applied to the field in place of the kraal manure. Applications of compost were at first light—not more than three tons per acre, but have now been increased to ten tons per acre. No tobacco has yet been grown after maize treated with the heavier dressing.

Field B.—Was virgin land, stumped and ploughed in 1930. The field was

¹ Tobacco (f) signifies tobacco fertilized. The fertilizer used throughout, on all fields, was a double complete mixture (of analysis P_2O_5 18.5 per cent, N 6 per cent, K 12 per cent), applied broadcast before planting at the rate of 120 lb. per acre. No fertilizer was used in the 1931-32 season.

divided into eight blocks, each of one acre in extent, and was first cropped in the 1931-32 season. The rotation was as Field A: tobacco (f); tobacco (f), sunn hemp ploughed under, and then maize. No kraal manure or compost has ever been applied. The field was principally used for detailed variety trials of tobacco and maize. Data gained from these trials have been made the subject of a separate article. [2] It is sufficient to say that White Stem Orinoco, Willow Leaf, and Yellow Mammoth established an ascendancy over Cash, Gold Leaf and Hickory Pryor. Many other varieties which were experimented with fail to merit further mention here. This field has been continually under crop and its rotational behaviour has been closely observed.

Field C.—Also virgin land, was first opened in 1930 and planted in 1931. This field was designed to assess the effect on yield and quality of leaf of varying frequencies of green manuring and also to investigate the effect of artificial fertilizer, then sparsely used within the district. To this end, six rotations were incorporated in an experiment embodied in thirty plots, each a quarter of an acre in extent. There were thus five replications of each treatment. A randomized block lay-out was adopted.

Field E.—Four acres in extent, was opened in February, 1937, and planted with tobacco in December of that year. This afforded a comparison of tobacco on new land with that on the older fields.

Including this last, there are thus nine different soil treatments under observation. These will now be discussed.

OBSERVATIONS

Field A. — Rotation: tobacco (f); tobacco (f); sunn hemp (composted); maize grown on compost. In all, this field has been under cultivation for fourteen successive years. It has unfailingly yielded

good crops of both maize and tobacco. The kraal manure or compost, as included in this treatment, has had a remarkable effect on the fertility of the soil, and bumper crops of maize have been reaped, yielding up to 3,600 lb. per acre. The maize has been used to ration labour, and the stalks fed to the cattle or composted. Allowing for various unsuitable varieties and unfavourable seasons, it can safely be said that there has been no decrease in fertility, but rather the reverse. No ill-effects have been noted on the tobacco crop that could be attributed to the use of organic manure. Cutworms have been conspicuously absent. Heavy yields have been recorded, varying from 500 to 1,200 lb. of cured leaf per acre, according to season and variety. The greater portion of the leaf has been of sound bright and long semi-bright grades; in short, the type of tobacco bringing in the largest financial return per acre. On the whole, the crop has been remarkably free from disease, with a minimum proportion of undesirable dark tobacco. The growing of maize with compost, following sunn hemp, has apparently tempered in an admirable fashion the effect on the tobacco of the organic manuring, and the leaf has not been too coarse, while the additional humus has enabled the crop to withstand both drought and flood.

Field B. — Rotation: tobacco (f); tobacco (f); sunn hemp; maize. In both yield and quality this rotation was unsurpassed for five seasons. The tobacco grew well, matured quickly, and gave returns up to and over 1,000 lb. per acre. The proportion of bright leaf was very high and "darks" were negligible. Disease, cutworms and other troubles were entirely absent.

However, since 1937, there have been unmistakable indications that the fertility of this field has declined, and it is evident that this rotation, with its absence of

organic manure, is not one which will enable the land to be cropped indefinitely.

Field C.—The six rotations incorporated in Field C were as follows:—

- A. Tobacco (f); sunn hemp.
- B. Tobacco (f); tobacco (f); sunn hemp.
- C. Tobacco (f); tobacco (f); tobacco (f); sunn hemp.
- D. Tobacco; tobacco; tobacco; sunn hemp.
- E. Tobacco (f), continuous.
- F. Tobacco (f); tobacco (f); pigeon pea; pigeon pea.

The series leaves much to be desired in the matter of completeness, but it was feared that further additions would make the trial too complicated—a fear which subsequent experience fully justified. Presentation of the complete results would occupy too much space, but the yields in pounds per acre, without reference to grades, are summarized:—

Rotation.	Year					
	1931-2	1932-3	1933-4	1934-5	1935-6	1936-7
A	822	S.H.	716	S.H.	526	S.H.
B	826	536	S.H.	656	498	S.H.
C	877	530	507	S.H.	494	271
D	791	566	431	S.H.	450	225
E	780	625	507	485	410	193
F	825	512	P.P.	P.P.	525	295

S.H.—Sunn hemp. P.P.—Pigeon pea.

The bad season during the critical year 1935-36, when all rotations came into tobacco, almost certainly masked differences due to treatment. Statistical analysis showed that the final yields of rotations A, B, C and F were significantly greater than those of E. Rotations A and F were significantly superior to D. In an experiment of this nature, however, more can be learnt from observation. Observations made throughout the duration of the ex-

periment, and simultaneously in the other fields, lead to the following conclusions:;

- (a) Tobacco should not be grown on a field for more than two successive years. It may develop well enough in the third year, but will almost inevitably suffer badly from disease, the organisms of which have been carried over from the preceding tobacco crops.
- (b) Green manuring prolongs fertility to some extent. Each tobacco crop should be fertilized, as this substantially increases the yield and enhances quality and texture to a degree which may safely be evaluated at a minimum of $\frac{1}{2}$ d. per lb. under local conditions.
- (c) Pigeon pea proved to be a satisfactory green manure. It is of great value as a standing crop in which cattle may browse in the months of September and October, and also penetrates deeply into the subsoil, enriching it and at the same time adding to the humus of the surface layers.

- (d) The steady decline in yield of all plots in Field C indicates that none of the rotations in this field can maintain fertility for long. The figures recorded in the final season are valueless, as disease had spread from D and E to other treatments, which should not have been affected. In addition, during the latter years of the experiment, some leaching of fertilizer occurred, which undoubtedly enhanced the yields from treatment D.

Field E, cleared in 1937, was given very thorough prior cultivation and was planted with tobacco (f) at the same time as Field A, to which it is contiguous. The tobacco on Field E developed very poorly while that on Field A was excellent. This

constituted a very satisfactory demonstration of the superiority of the rotation on Field A over even new land, well tilled and cultivated.

The general conclusion from all these observations is that "tobacco (f); tobacco (f); sunn hemp, composted and returned to the field; maize," is evidently the only one of the nine treatments which will maintain natural fertility. It will even increase it. So much for a short review of the rotational experiments. But there are other factors which require consideration and certain points which must be amplified before the completed picture can be presented.

Erosion.—The experimental fields are protected against erosion by broad-based ridges, falling at a slope of 1 in 240 from the contour levels. These ridges are some 15 feet in width and 18 inches in the centre. They are not included in the general scheme of cultivation but are allowed to become grass covered, and have been found to minimize erosion in a satisfactory manner. Enough has been written in both lay and technical journals on the national and universal dangers of soil erosion to render it unnecessary to enlarge on this subject here, except to point out that most of the terrain of Fort Jameson district is particularly susceptible to this evil. Should it be undesirable for any reason to construct anti-erosion ridges, erosion can be greatly decreased by causing the tobacco ridges to be made on a gentle downward slope, so graded as to minimize scouring and to prevent washaways.

Compost.—In the local application of composting, sunn hemp forms the cheapest and most abundant source of vegetable matter, while maize stalks, thatching grass and tobacco primings are also used. A tobacco estate is particularly rich in additional ingredients, as all the

ash from the ovens of the tobacco barns can be thrown into the compost pit, and on the Agricultural Station, as a measure of control of "cabbaging" of tobacco, the tobacco stalks are uprooted at the end of harvest, stooked, dried and burnt. The ashes from this source are also added to the compost. For the sake of sanitation in the compound all ashes and rubbish are thrown into old fertilizer drums set at intervals round the compound. This source contributes half a ton of material every week to the compost. It is estimated that this compost costs approximately 2/- a ton to make and apply to the field, inclusive of sowing and cutting the sunn hemp. Its manufacture does not necessitate much additional labour, as the work has been made to fit in with the ordinary farm routine. Cutting the sunn hemp and turning the compost heaps is mostly done on days when the land is too wet for work in the tobacco fields.

Ploughing is an important consideration in this rotation. It has been reduced to a minimum on the Station, both in order to avoid expense and also to avoid unnecessary pulverization of the soil and loss of its granular structure. Commencing with virgin land, ploughing and cultivation proceeds normally for the first two tobacco crops. When the second tobacco crop has been reaped, the stalks are uprooted immediately and the field left untouched until the beginning of the rains in November. When the soil is moistened, the field is disc-harrowed parallel to the tobacco ridges, and the sunn hemp seed is sown broadcast and covered over by a cross-harrowing. In due course the sunn hemp stalks are cut and composted, and the stubble left until the end of the following October. The compost is then carted out and left in heaps until rain makes ploughing possible, when it is spread and ploughed under. By this method both the maize

and sunn-hemp are sown before the end of November, leaving the normal time for tobacco planting during the following six weeks. "Contour" ploughing is practised, the most useful implement for which has been found to be a two-disc reversible plough. This only requires ten oxen and will do a genuine acre a day.

Insects and Disease.—The four-course rotation advocated here has been found satisfactory for the control of pests and diseases of tobacco. Eelworm is a steadily growing menace to tobacco in the Rhodesias, but both sunn hemp and maize are highly resistant to *Heterodera marioni*. It has been observed locally that successive crops of sunn hemp and maize can reduce field infestation by eelworm to negligible proportions.

Expense.—As to the cost of the advocated rotation, the two tobacco crops presumably show a profit, the maize should pay for itself, and the sunn hemp composted is estimated to cost about 20/- an

acre. It cannot be argued that this procedure is unduly extravagant, as the only alternative is continual, wasteful and expensive clearing of fresh land, which process costs about 30/- an acre and ultimately necessitates the purchase of a new farm and erection of new buildings. Tobacco is a high-priced crop, bringing in a gross return of some £20 per acre under present local market conditions. It will stand, and respond to, liberal treatment.

In view of local observations it is confidently believed that the rotation here advocated can be adopted with advantage on the majority of the tobacco estates in the Fort Jameson district and probably in other areas of similar soil and climate.

REFERENCES

- [1] R. H. Fraser (1933).—"Practical Notes on a Suggested Rotation for the Fort Jameson District," *3rd Ann. Bull., Dept. of Agric., N. Rhodesia*.
- [2] R. H. Fraser (1933).—"Variety Trials of Tobacco," *ibid.*

TREES

SELBORNE, Feb. 7th, 1776.

"In heavy fogs, on elevated situations especially, trees are perfect alembics; and no one that has not attended to such matters can imagine how much water one tree will distil in a night's time, by condensing the vapour, which trickles down the twigs and boughs, so as to make the ground below quite in a float. In Newton Lane, in October 1775, on a misty day, a particular oak in leaf dropped so fast that the cart-way stood in puddles and the ruts ran with water though the ground in general was dusty.

"In some of our smaller islands in the West Indies, if I mistake not, there are

no springs or rivers; but the people are supplied with that necessary element, water, merely by the dripping of some large teak trees, which, standing in the bosom of a mountain, keep their heads constantly enveloped with fogs and clouds, from which they dispense their kindly never-ceasing moisture; and so render those districts habitable by condensation alone.

"Trees perspire profusely, condense largely, and check evaporation so much, that woods are always moist; no wonder, therefore, that they contribute much to pools and streams."

—Gilbert White, *The Natural History of Selborne*.

THE ROOT-SYSTEM OF SISAL IN SOME EAST AFRICAN SOILS

By J. Glover, M.Sc., Plant Physiologist, East African Agricultural Research Station, Amani, Tanganyika Territory

The root-system of sisal has generally been regarded as shallow and of small lateral extent. The plant grows well on a great variety of soils, but of the influence of soil type upon root habit little has been known.

During 1937-38 a field investigation was made of the root-system of sisal in relation to some typical soils on which it is grown in East Africa.

The root-systems of the plants were excavated by means of water jets provided by a powerful motor-driven pump. A vertical sector of the root-system was obtained by washing away the soil from the roots in the vertical face of a trench extending from the base of the plant to a distance of ten or more feet away. As a check the whole root-system of several plants was excavated, and it was found that the trench sector method gave a reliable indication of the whole. Hand excavation was resorted to if the water method failed owing to the hardness of the soil. As the roots were exposed they were pegged in position and drawn to scale with the aid of a string grid of one foot squares.

After preliminary trials on plants of various ages, those of the age group $4\frac{1}{2}$ to $5\frac{1}{2}$ years were chosen as having attained their maximum development. In one area, plants of twenty years of age were investigated. Plants were chosen as good specimens for their locality. They had all reached a height of 5 ft. above ground, except on certain poor soils (Nos. 2 and 6). The field spacing in all cases was 2.5 metres x 1 metre. They had all been cleaned twice annually by cutlassing the weeds between the rows.

The acidity or alkalinity of the soil was measured as was also the water-retaining capacity of two extreme types of soil, one almost pure sand, the other a fairly heavy loam.

The diagrams that accompany the paper are on a uniform scale; each square represents one square foot of the vertical face of the sector.

Certain terms that are used throughout the paper are explained below:—

Bearers.—Long, often well-branched main roots which carry the feeder roots. They appear brown and shrivelled owing to the suberization of certain cell layers. The root tissue outside these layers gradually dies, so that the bearers are unable to feed and become in the main conducting strands only. The last 6 to 18 inches of the bearers, behind the growing points, is white and bears a number of root hairs. This part of the bearer still functions as a feeding root. Young bearers about 1 to 4 feet long are frequently completely white, but they soon show the brown shrivelled appearance of the older bearers as suberization gradually extends along them. The bearers are usually about 2 to 4 mm. in diameter.

Feeders.—Thin white feeding roots which arise as branches of the bearers. They bear numerous root hairs. As they grow in length they gradually show suberization which extends outward from the parent bearer. The feeders are of average diameter 1 to 2 mm.

Rhizomes.—Creeping underground stems, which turn up at their ends to produce suckers. They are white and fleshy, and bear brown scale leaves, together with a few feeding roots. Rhizomes vary greatly in thickness.

Suckers.—Young sisal plants developed vegetatively from the rhizomes. They produce a small root-system corresponding to that of the parent plant.

Poling Plants.—Plants in which the large, pole-like reproductive shoot is developed at the expense of the vegetative organs. It brings leaf production to an end and results in the death of the plant.

The results are assembled in summarized form below, under two general headings: the root-systems found in *acid soils* and those found in *alkaline soils*.

ACID SOILS

(1) *Altitude about 2,900 ft.*—A laterized red loam developed on acid crystalline rock, a characteristic soil of humid tropical mountain regions. The top 3 to 6 in. of the soil has a moderately high content of organic matter. Below this layer a soft red clay loam is found to a depth of 30 in. Below this depth the soil contains much rock brash and is raw red in colour. The average annual rainfall in this region is about 70 to 75 inches, well distributed throughout the year. Drainage is good.

The root-system of the sisal plant in this area had its main concentration of roots in the top 18 in. of soil, although roots were found to a depth of 3 ft. The bearers extended radially from the base of the plant to a maximum distance of 10 to 14 ft.

(2) *Altitude about 1,000 ft.*—A black or grey clay, a characteristic soil of escarpment-foot areas. The top layer of the soil is stiff and cloddy, becoming yellow below a depth of 18 in. Drainage is poor, and there is a flowing water table at a depth of 5 ft. The average annual rainfall in this area is about 45 in.

Plants on this soil were not as well developed as those on soil (1). The root-systems of the plants were poor. The main concentration of roots was in the top 24 in. of soil. Bearers spread radially to a maximum distance of 9 ft. only (see Fig. 1).

(3) *Altitude about 100 ft.*—A fairly open brown sandy clay, a typical soil of the coastal sedimentary belt. Drainage is good. The average annual rainfall of the area is about 50 in.

Two groups of plants were investigated in this area. One group consisted of 5-year old plants, the other of 20-year old plants.

The root-systems of the 5-year old plants were similar to those of soil (1). The main concentration of roots was in the top 29 in. of soil, though bearers were found to a depth of 3 ft. The bearers extended radially to a maximum distance of 10 to 15 ft. from the base of the plant (see Fig. 2).

The root-systems of the 20-year old plants were poorly developed. The roots were confined to the top 18 in. of soil. The bearers were few and bore few feeders.

ALKALINE SOILS

(4) *Altitude, Sea-level.*—In this soil plants were growing within 20 ft. of tidal high-water mark. The soil is a coarse coastal sand which contains some organic matter in the top foot, below which almost pure sand is encountered. Drainage is good. The average annual rainfall in this area is about 45 in., well distributed throughout the year.

The amount of water that this soil could retain was measured. It was found that the top foot of soil was able to retain twice as much water as the second foot. The maximum amount of water that could be retained was low, being of the order of 10 per cent of its dry weight.

Plants in this area were healthy and of average size for their age. The root-systems formed a dense mat in the top 12 to 14 in. of soil. A few dead roots were found in the underlying layer of almost pure sand. Bearers extended to a distance of 10 to 15 ft. from the base of the plant.

(5) *Altitude about 2,500 ft.*—The soil in this area is a fine volcanic alluvium of even consistency to a depth of at least 7 ft. Drainage is good, although there is

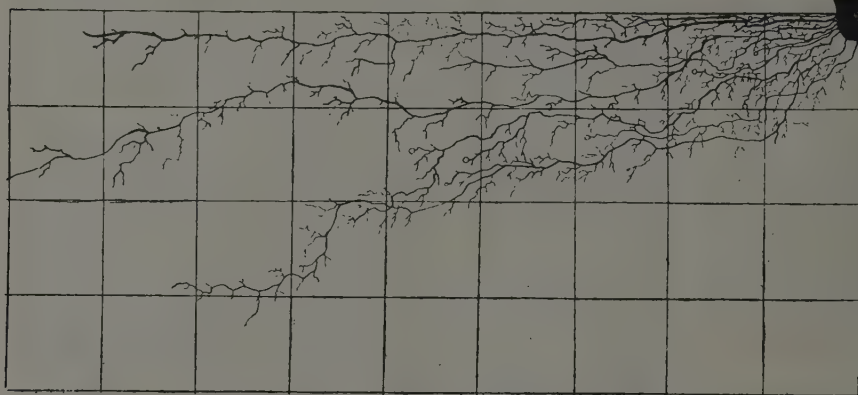


FIG. 1.—The root-system of sisal in a poor soil.

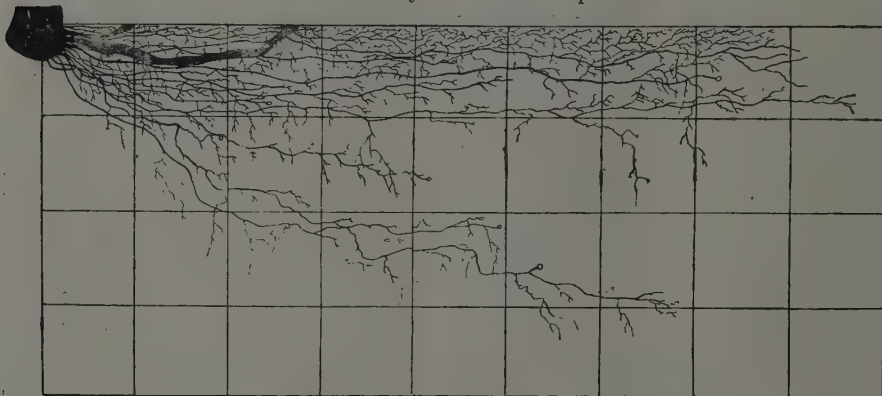


FIG. 2.—The root-system of an average healthy 5-year-old sisal plant in a soil of medium texture and good drainage.

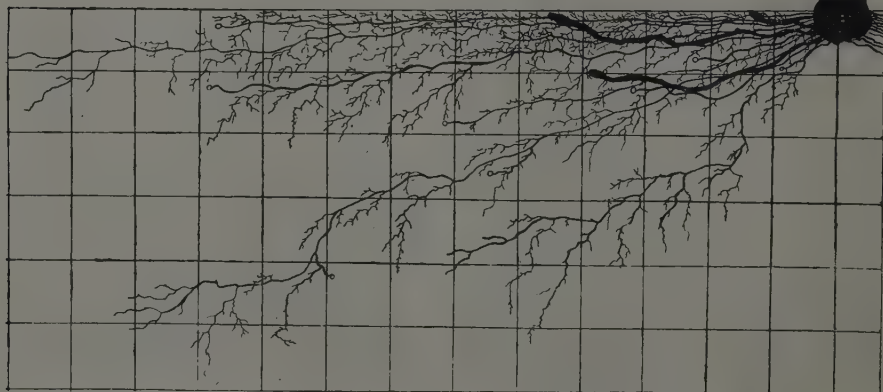


FIG. 3.—The root-system of sisal in a deep loamy soil.

a water table at a depth of 7 ft. The average annual rainfall in this area is about 25 to 30 in., badly distributed.

The main concentration of the root-systems of plants in this area occurred in the top 24 in. of soil; but a number of roots were found to a depth of 5½ ft. Bearers spread radially to a maximum distance of 10 to 15 ft. In the layer between 5 and 6 ft. deep, a number of dead feeders were found.

(6) In the same area and under the same annual rainfall, a different type of soil occurs, a very alkaline young volcanic soil. There is a clayey pan formation at a depth of 27 in. Drainage is poor.

Plants in this soil were poorly developed for their age. Both bearer and feeder roots were few in number, and were concentrated in the top 27 in. of soil. A few feeders were found which had penetrated cracks in the hard pan to a depth of a few inches. Bearers extended radially from the base of the plant to a distance of 6 to 9 ft. It is of interest to note that in this soil even weed growth is poor.

(7) *Altitude about 2,500 ft.*—The soil is weathered volcanic debris. It is a loamy brown soil which resembles in many ways the clays of temperate regions. Drainage is good. The average annual rainfall is about 25 to 30 in., badly distributed. This soil proved to be capable of holding water to the extent of 30 to 40 per cent of its dry weight. The root-systems of the plants examined were deep and well distributed. The main concentration of roots was in the top 24 in. of soil, though many roots were found to a depth of 6 ft. Bearers extended to a distance of 10 to 15 ft. from the base of the plant (see. Fig. 3).

DISCUSSION

There is little doubt that the sisal plant is in the main a surface feeder; but although the main concentration of its root-system is in the top 30 in. of soil

many roots may be found in certain good soils to a depth of five or more feet. An average five-year-old plant on a soil such as (3) in which the main concentration of the root-system is in the top 29 in. of soil represents a "normal" type. The lateral extension of roots in this soil is 10 to 15 ft.

If the lateral extension of the root-system of an average fully grown sisal plant is 10 to 15 ft., it will be obvious that under present East African planting practice a spacing of 2.5 m. x 1 m. (8 ft. by 3¼ ft.) means that there is a large amount of root-competition between the rows and between plants in the same row. This intense competition must have an effect on the growth of the plant, and this is well shown by the spacing trials conducted at the Sisal Experiment Station, Mlingano. In these trials Mr. Lock has shown that the growth of the leaves may be increased by wider spacing.

There is also very marked competition between the roots of sisal and the roots of normal weed growth, as the weed roots occupy the same layers of soil as the sisal roots. This competition is very severe on the sisal plant in areas in which there is a badly distributed rainfall and often a deficiency of soil moisture. The removal of this competition must undoubtedly help the sisal root-system, and it is well illustrated by the "clean-weeding" field trial being carried out at Mlingano. There it has been shown that a clean-weeded plot produces better plants with a larger leaf yield and at the same time gives an earlier crop.

As rainfall is an important factor in the growth of the plant, it is of prime importance to find out what use the soil makes of it. Rainfall and the physical structure of the soil cannot be considered as separate factors in the growth of the root-system except in extreme cases. Two examples of the interdependence of these two factors can be quoted from the

present investigation. In soil (4) a well drained sandy soil which only holds water to 5 to 10 per cent of its dry weight, there is a good growth of sisal. The annual rainfall in this area is well distributed throughout the year and averages about 50 in. As a result the roots are continually being supplied with the necessary water. In soil (7), a moderately well drained loamy clay which can hold water to an extent of 30 to 40 per cent of its dry weight, there is a good growth of sisal. The annual rainfall in this area is badly distributed throughout the year and averages only about 25 in. Here the water-retaining capacity of the soil is an important factor in the maintenance of the water supply to the plant for a period after heavy rains. Although sisal can grow under dry conditions, it does not prefer them. Like almost all other plants, it prefers to have plenty of water available to its roots. This is obvious to the sisal grower when he sees the effect of a long dry period reflected in the decreasing growth rate of the sisal leaves and the necessity of altering his cutting cycle. There is, however, a great difference in the reaction of soils to a drought. Given a similar set of drought conditions, the reaction of the above-mentioned loamy-clay and sandy soils to such conditions would be different. The sandy soil, holding only a small store of water, will soon be exhausted of its supply and the plants will be severely affected. During the same period the plants in the loamy clay soil, which holds more water, will still have sufficient for their growth and will not show the effects of the drought for a long time. The rate of recovery from severe drought conditions is also affected by the nature of the soil. In the sandy soils slight showers of rain will penetrate to the deeper layers and almost immediately be available to the root-system of the plants. In a loamy clay soil slight showers

of rain will be absorbed in the top few inches of soil, leaving no "free" water for the deeper root-system. As a result, plants in this soil will take longer to recover.

From the above results, it is clear that sisal cannot be said to require a rainfall of so many inches a year in order to thrive but rather that it requires the rainfall that suits the soil type on which it is being grown. A thorough study of the soil in conjunction with the rainfall data for the area is necessary if the plant is to be grown under optimum conditions. The effectiveness of the rainfall also depends on the proportion intercepted by the leaf systems of weeds growing between the rows. Slight showers of rain will not reach the ground, and the water so intercepted will be evaporated before it can be made available to the plant.

The acidity or alkalinity of the soil within certain wide limits does not appear to be an important factor in the growth of the plant. In only one case (soil (6)), an exceptionally alkaline, badly drained soil containing a large concentration of alkaline salts, was there any sign of poor growth due to the chemical nature of the soil. In East Africa sisal has been grown on acid soils for many years, and there is no evidence to show that the yield of leaf or strength and fineness of the fibre suffers in any way from that particular cause.

During the course of the investigation it was noticed that at the beginning of poling there is no apparent difference between the root-systems of "poling" and "non-poling" plants; but as the poling shoot matured the root-system of the poling plant showed progressive degeneration of the feeding roots.

It is a matter of general knowledge that sisal does not grow well on swampy soils. It is, in fact, so intolerant of such conditions that the presence of a water table causes the death of roots to a height of 12 to 18 inches above it.

PRIMITIVE AGRICULTURAL METHODS OF THE WEST SUK TRIBE AND SOME IMPROVEMENTS

By G. H. Chaundy, M.B.E., B.Sc. (Agric.) (Lond.), Education Officer, Kenya Colony

Before the year 1930 little had been done to improve the conditions of the West Suk tribe; in the past the work of the administrative officers had been chiefly in preventing inter-tribal raids. When I was posted to this district in January, 1931, my first duties were "to make a close study of the Suk, with respect to the best methods to adopt in the new school to help them socially and economically." From February to May of that year extensive tours of the district were undertaken on foot. In a letter, the District Commissioner wrote, "The Suk are backward and conservative to a degree and it will be a long uphill task to win their confidence and secure any active interest and support from them for any scheme inaugurated for their benefit." At this time they were famine stricken, as little or no rain had fallen since the previous September, and locusts had eaten their first crop of sorghum. Even the pastoral Suk were not getting enough to eat, as there was little grazing for the cattle, and they were unable to obtain any grain from the agricultural section as they usually did during a dry time. People were eating berries from trees, rats, and in fact anything they could find. As a result of these tours I came to the conclusion that something ought to be done to improve the conditions of the people in the reserve in addition to conducting a school at Kapenguria for their sons. Owing to lack of funds the maximum number of pupils that could be taken was sixty, and it was felt that this would not have much effect upon the West Suk tribe with a population of 23,000. In this article I am not concerned with the development of the school, but with the

agricultural work in the reserve run in conjunction with it.

It was found that the tribe could be divided into—

(a) The Pastoral Suk, who possessed cattle. They inhabited the plains around Kacheliba, Kipkomo, Masol, etc. They did no cultivation, but lived chiefly on milk and blood. When milk was short during the dry seasons, it was the usual custom to bleed their cattle. Meat was eaten only on special occasions.

(b) The Agricultural or Hills Suk, who had little or no stock. They lived on the steep hill slopes, and practised a primitive form of agriculture. Only two crops were grown, finger millet (*Eleusine coracana*) on the steep hillsides and sorghum on the flat land near the main streams.

Finger Millet.—Patches on the hill slopes were chosen in the dry season and the undergrowth cut down. This was piled round any large trees and fired, thereby destroying the majority of trees. After burning the undergrowth, grass, etc., the land was merely scratched over with a primitive hoe or digging stick. As soon as the long rains started the seed was broadcast, and owing to the steepness of the slopes the writer has seen not only the soil washed away but the seed also. Steep hillsides were chosen as the local people say that when grown on the flat the millet is attacked by a disease called *cheptaita* (rotting of the developing "fingers," which, as a result, do not set seed). It was planted at altitudes varying from 5,000 to 8,000 feet, and was harvested four to five months after planting. After harvesting, the patch was left and the next year another piece of the forested hillside was

destroyed and prepared for planting. On most hillsides in West Suk bare places could be seen—the sites of former *shambas*. It was realized at once that this primitive method of agriculture was gradually reducing the forested slopes to bare rocky wastes. After the seed had been planted and before the crop had time to take root, extensive erosion took place. The people were also destroying the forests along the streams running down the hillsides. At this stage it was useless to prohibit the cultivation of hillsides owing to the lack of staff to enforce the application of any rules made. Finger millet had been the staple food of the people for generations; it is nutritious and will stand storing for a considerable time.

Sorghum.—In the locations of Mwina, Weiwei, Lomut, Cheptulel and Marich there was a definite system of land tenure, in contrast to the pastoral locations, where all grazing was communal. Two crops of sorghum were grown per year, one planted in April or May and harvested in September, and the other planted in October and harvested in February or early March. For the growth of the first crop the people relied on the rains and irrigation was only resorted to when there was a dry period, but the second crop, though planted before the rains stopped, was irrigated during its later growth. It was a crude but effective form of irrigation. Main furrows were dug from the streams just before they came to the flat plains. These main furrows were taken out roughly at right angles to the streams, and from them smaller furrows were constructed. As the land was flat there was little soil erosion.

After harvesting the crop the land was allowed to rest for two seasons and reverted to bush, so only one-third of the available cultivable land was under a crop at one time. In this way the land was not worked out; these light sandy

soils easily lose their fertility if continuously cropped without rotation or manuring.

When plots were prepared the following procedure was followed: The trees were merely lopped and not destroyed, the branches being used as fences. All undergrowth was cut, put into heaps and burned. The land was then dug with primitive hoes, a type of hard wood being sharpened and used for the blades. Very few people had metal hoes. While the women were digging, the men were opening up the water furrows. Each family's plot was marked by boundary stones and often an irrigation furrow. As soon as the rains came, usually towards the end of April or early May, the seed was broadcast. When about six inches high, the crop was thinned and weeded. It was the custom of the people to leave too many plants, with the result that the crop was often badly "laid" during high winds or storms. When the crop was ripening platforms were built on which children sat, scaring away birds. It was harvested towards the end of September by cutting off the ears. The women undertook the threshing. It was stored in the huts where the people lived, a platform being built about the height of the eaves.

Five distinct varieties of sorghum were grown by the people, at altitudes varying from 3,000 to 4,000 feet:—

Mukuwon (meaning "dark coloured").

—The grain is reddish-brown in colour; growing period from four to five months; heavy yielder.

Pakulipok ("large seed").—Grain reddish-brown in colour; growing period four to five months; heavy yielder. The Suk plant more of this than any of the other varieties.

Piton ("quick to ripen").—Grain red in colour; early maturing; growing period three to four months; usually

planted in November if people are behindhand with work of preparing ground for planting; only fair yielder.

Pkaran ("thin head").—Grain light in colour; growing period four to five months; particularly sweet to the tooth, but not such a heavy yielder as *Muruwon* or *Palulipok*.

Limuk ("covered ear").—Grain light brown in colour and covered completely by the chaff; growing period four to five months; grain much harder than the others and not so readily eaten by birds.

Contrary to previous reports, it was found that the parts of Suk where agriculture was practised were well watered, and in a normal year the rainfall would

finger millet and sorghum in the years 1928 and 1930 and to a lesser extent in 1931. As a result of this there was a famine amongst the agricultural section of the tribe. Owing to the extreme apathy and conservatism of the people, they were averse to any new ideas and regarded with suspicion a European in their midst. A scheme was evolved towards the end of the year whereby small seed farms would be started in some of the agricultural locations to try out new crops. The District Commissioner was in sympathy with this scheme, but was rather sceptical of the whole thing, as he said the Suk were apathetic to a degree and to ensure success constant supervision would be necessary.

In the meantime a communal garden had been started at the school. When the boys saw that good yields were obtained they at once started to clear plots of their own. They reaped particularly heavy crops of English potatoes, and the elders called the school "the place where you eat potatoes." Every endeavour was made to impress on the chiefs and headmen when they visited Kapenguria the urgent need for improving the food supply of the people in the reserve, as well as introducing improved methods of agriculture. At a meeting of the Local Native Council held in August, 1931, I outlined a scheme for helping the people to increase and augment their food supply. This was that each location should have its own agricultural demonstration plot and seed farm. It was explained that the benefits would be threefold—

To introduce new crops to the district;

To teach the people better methods of agriculture, special attention being paid to soil conservation;

To be a seed distributing centre.

With the exception of one man, who said he would give it a trial, the majority

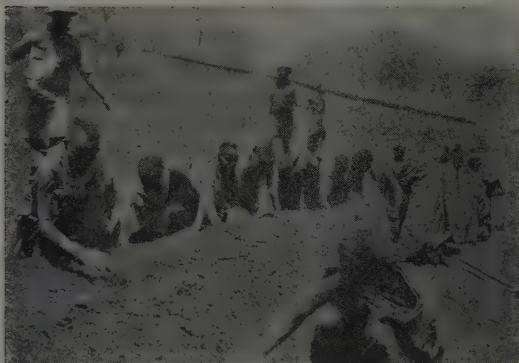


Wholesale forest destruction on the banks of a stream, with resultant erosion.

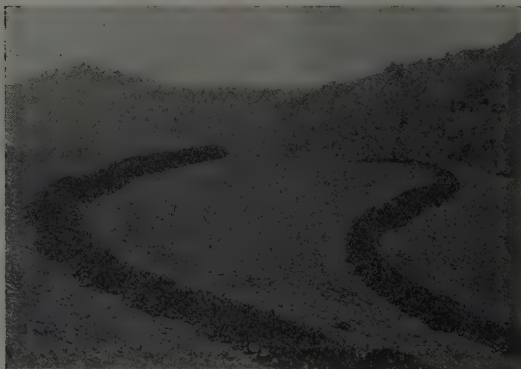
be sufficient for the growth of a large variety of crops. During several tours of the district in 1931 many meetings were held and the advantages of introducing new crops were explained to the people. Locusts caused great damage to the



The initial stages in making a contour ridge. The instructor is using a line level.



The final stages in making a contour ridge—making the soil firm and cleaning out the drain above the ridge.



Sweet potatoes growing on the contour ridges. This photograph was taken after a four months' drought. It shows the drought-resisting character of sweet potatoes.

of chiefs, owing to sheer laziness, said they did not welcome the suggestion.

THE STARTING OF AGRICULTURAL WORK IN THE RESERVE

Early in 1932 the Agricultural Department posted a native agricultural instructor to West Suk. He was a man who had had a thorough training and also had had experience in the Kavirondo district. He worked in the school at Kapenguria for a month, where he picked up a fair knowledge of the Suk language. Then he went



Rose Coco beans growing between the rows of maize. The beans are planted just as the lower leaves of the maize wither. They act as an additional soil cover, and increase soil nitrogen.

on a tour of the district with me, and we chose a site for the first demonstration plot in the Mwina location. It was in a fertile valley at an altitude of 4,000 feet. At first the people were suspicious and put every conceivable obstacle in the way. They said I was sent out by the European farmers to see what crops would grow, and when it was proved what parts

of the district were fertile they would take the land from the natives. However, an area of about four acres was cleared and fenced, the agricultural instructor's hut was built, and the plot prepared for planting. It was difficult to get seeds and planting material out to the plot owing to the lack of motor roads. The Agricultural Department were most helpful in supplying seeds suitable to the altitude and climatic conditions. The first year the following crops were tried: Yellow maize (which was later interplanted with Rose Coco beans), groundnuts, sweet potatoes, cassava, pigeon pea, and bananas.

When the crops were harvested they were given out to the people to sample, sufficient seed being retained. At the same time, demonstrations were given in the proper ways of preparing and cooking the various foods. I might add that all the crops gave good yields and, with the exception of pigeon pea, were readily eaten by the people. The natives in other locations soon heard that the new crops were sweet to the tooth, and at a meeting of the Local Native Council held in August, 1932, various chiefs asked if demonstration plots might be started in their locations. They were informed that if they set aside money in the following year's estimates for the payment of ex-schoolboys to look after these plots they would be started. The funds at the disposal of the Council were meagre, but sufficient to pay boys in charge of these plots Sh. 8 a month. In the meantime, at the school, special instruction was being given in agriculture to eight selected boys, so that they could take charge of these plots the following year.

PROGRESS MADE DURING 1933

Early in the year six more demonstration plots were started, with ex-schoolboys in charge. The sites were selected and

personal supervision given to clearing, fencing and preparing for planting. There were now seven plots in all, three of which were in the hills zone (altitude 6,000 to 7,000 feet), where sub-tropical crops were grown, and the other four in the plains zone (altitude 3,000 to 4,000 feet). Owing to the broken nature of the country in the hills zone the sites chosen for the plots were on sloping land, in order to teach the people methods of soil conservation. The work of the native agricultural instructor was now to tour the seven plots and give advice to the ex-schoolboys in charge. As a general rule, I was only able to go on *safari* during the school holidays, and owing to the lack of transport these tours had to be undertaken on foot, necessitating being away for about three weeks. On each occasion meetings were held at each plot, and the uses of the new crops under trial explained to the people.

When the crops were harvested they were given out to the people to try, sufficient seed for the next year being retained. Crops they liked very much were planted up more extensively the following year, and anything they definitely disliked was discarded. For instance, they did not like the tubers of edible canna nor, they stated, would the cattle eat the leaves. On one plot, awned bulrush millet was tried (the awned character was not fixed), and the people complained that it brought birds.

As far as is known, no medical officer has ever reported on the health of the people in the West Suk Reserve, but to the lay eye they seemed to be suffering from food deficiency diseases; ulcers and sores were also common. This showed the necessity of introducing fruit and vegetables.

At the end of the year very few people had grown any of the introduced crops. This was not surprising, considering the

apathy and conservatism of the people. But the encouraging feature for future development was that they ate a number of crops, and, in time, would plant them in their own fields. Reports were sent in from time to time saying that bananas had been stolen from the plantations, and potatoes, maize, groundnuts, etc., taken from the stores.

FURTHER PROGRESS, AND THE PLANTING OF INTRODUCED CROPS BY THE PEOPLE

In 1934 another demonstration plot was started in the hills zone, an ex-schoolboy being placed in charge. The people had already planted maize, the seed of which was obtained from the plot in another location.

In the plains zone, people started to plant up banana suckers, sweet potatoes and cassava, and to a lesser extent yellow maize. Although groundnuts were regularly given out for planting, none were seen growing. One day I met an old man after he had been issued with seed and asked him where his groundnuts were. He replied, "I really meant to eat half and keep half for seed, but I was hungry and the groundnuts were so sweet that I finished them all on my way home." In the hills zone, English potatoes, white maize and sweet potatoes were planted by the people.

On all the demonstration plots contour ridges were made, with sweet potatoes planted on them to bind the soil. The people were told that if the top soil was washed away they would not get good crops. Each able-bodied male works for a week per year on the plot in his location, so that approximately 3,000 young men learn better methods of agriculture by "seeing and doing".

It is continually stressed at all meetings that if the people follow better methods of agriculture there is no need to practise shifting cultivation.

Emphasis was laid on the following points:—

- (1) A definite rotation should be followed.
- (2) All crop residues should be dug in and not burnt.
- (3) Leguminous crops should be inter-planted with maize and sorghum.
- (4) If available, *boma* manure should be applied from time to time.
- (5) Before the onset of the dry season, drought-resisting crops such as *njahi* (Bonavista beans, *Dolichos lablab*) or Madagascar butter beans should be planted to give a soil cover and so prevent leaching by the sun. These crops should be dug in as green manure before the next rains and so increase the soil humus.
- (6) The people should see that there is no erosion on their plots, by following the methods employed on the demonstration plots.

THE STATE OF THE RESERVE AT THE PRESENT TIME, AND PLANS FOR FUTURE DEVELOPMENT

There is little likelihood of a food shortage in future, owing to the fact that the people have planted a variety of crops. Banana suckers have been planted extensively in the plains zone and practically every family has its own plantation. Other crops doing well are sweet potatoes, yellow maize, cassava, pawpaw, groundnuts, onions and simsim. These are in addition to the sorghum and finger millet which the people have always planted. In the Weiwei location a community centre has sprung up around the demonstration plot, with the village school, dispensary in burnt brick, and two shops.

In the hills zone, white maize, English potatoes, sweet potatoes and vegetables are grown by the people. A few have modelled their *shambas* on the demonstration plots, where the same number of crops are grown, but on a smaller scale.

A water-driven grinding mill is shortly to be erected in the reserve, as the people have complained that the yellow maize is too hard to grind with stones. Some enterprising people have recently purchased hand mills for this purpose.

The people of Kipkomo, a pastoral location, said that during the long dry season the food problem became acute owing to the shortage of milk. A banana plantation was started last year, which is being extended at the present time, and it is hoped suckers will be available for distribution during this year's rains.

There is still far too much forest destruction, chiefly by the pastoralists, who burn patches of forest in order to cultivate finger millet, which, when harvested, tides them over the dry season when their cows are dry. Recently the Local Native Council has issued rules to stop this wholesale forest destruction, which is usually on steep hillsides near streams. But the lack of motor roads and adequate staff are serious handicaps in enforcing these rules.

In one of the badly eroded areas where the vegetative covering has been lost, chiefly by overgrazing by goats, a plot of about an acre was enclosed in 1935. It has now completely recovered and the indigenous grasses have spread all over the plot. It was hoped to close this area of approximately forty square miles for two years, but the elders, at a recent meeting, decided to close half of it. It seems that some system of rotational grazing will have to be instituted, to allow the grasses time to set seed and so propagate themselves.

In addition to the agricultural work going on in the reserve, boys who have been through the school are bound to adopt new and better methods. Some have already gone back and started plots of their own, but owing to the lack of marketing facilities the majority have started smallholdings near Kapenguria. They are helped the first year and given a certain amount of supervision. Eventually they are self-supporting, using their own cattle for ploughing. A cattle shed, similar to the one at the school, is erected and the manure made in it is used to keep up the soil fertility. All these holdings are contour-drained. Last year the majority of the Suk put in some form of stop-washes when their fields were on slopes, but this work needs extending.

Up to the present the Suk have not taken to green manuring, although the benefits derived from it have been seen on the demonstration plots. The soil on these plots is in better condition now than when they were started six years ago, though they have been continuously cropped. This is in no small measure due to growing crops each year (after the

main crops have been harvested) as green manure, i.e. digging them in when still green. In the plains zone, both *njahi* and Madagascar butter beans give tremendous vegetative growth, and the fertility of the light sandy soils on these plains is kept up and enhanced by turning them in. Every effort is being made to induce the people to follow this practice, which at the moment they do not appreciate. In my opinion, if soil fertility is to be maintained, the only alternative to the application of *boma* manure is green manuring.

In conclusion, I should like to place on record the help I have received from the administrative officers in this work of agricultural development. They have not only been in sympathy with the various schemes suggested, but have done their utmost to see that they have been carried out. I have worked in close collaboration with the Agricultural Officer, Kitale, who has supplied seeds and planting material of good, disease-resistant strains. Mr. Colin Maher, who toured the district with me in January, 1935, was most helpful, and his advice was greatly appreciated.

WORMS

"The acids in the alimentary canal of worms are formed during the digestive process, and probably they are nearly of the same nature as those in ordinary mould or humus. The latter are well known to have the power of de-oxidising or dissolving per-oxide of iron, as may be seen wherever peat overlies red sand, or where a rotten root penetrates such sand. Now I kept some worms in a pot filled with very fine reddish sand, consisting of minute particles of silex coated with the red oxide of iron; and the burrows, which the worms made through this sand, were lined or coated in the usual manner with their castings, formed of the sand mingled with their intestinal secretions and the

refuse of the digested leaves; and this sand had almost wholly lost its red colour. When small portions of it were placed under the microscope, most of the grains were seen to be transparent and colourless, owing to the dissolution of the oxide; whilst almost all the grains taken from other parts of the pot were coated with the oxide. Acetic acid produced hardly any effect on this sand; and even hydrochloric, nitric and sulphuric acids, diluted as in the Pharmacopœia, produced less effect than did the acids in the intestines of the worms."

—Charles Darwin, *The Formation of Vegetable Mould through the Action of Worms*, 1881.

LEGUMINOUS CROPS IN NATIVE AGRICULTURAL PRACTICE

By D. Sturdy, M.A. (Agric.), Senior Agricultural Officer, Tanganyika Territory

For the maintenance of soil fertility, and for the improvement of native dietary, the planting and use of leguminous crops is of value. It is accordingly the intention of this paper to review the customary practices adopted by some seven different tribes, divided into four groups, who inhabit the north-western portion of Tanganyika.

Taking the area as a whole one finds that all the tribes grow one legume or more, but that the particular legumes grown differ considerably from group to group. Thus the Wakara grow Bambara groundnuts¹ (*Voandzeia subterranea*) as a food and *Crotalaria striata* as a green manure for maintaining the fertility of their overcrowded and limited island soils; the Wasukuma and the Wanyamwezi, in the cultivation-steppe south of Lake Victoria, grow groundnuts (*Arachis hypogaea*) (the average exported surplus of this crop in the past three years has amounted to over 10,000 tons from the two tribes), Bambara groundnuts, cowpeas (*Vigna catjang*) and grams (*Phaseolus mungo*); the Bahaya to the west of Lake Victoria grow Bambara groundnuts and kidney beans (*Phaseolus vulgaris*); while the group of tribes of whom the principal are the Bazinza, Basumbwa and Baha, occupying the land between Lakes Victoria and Tanganyika, grow kidney beans in great quantities and great variety (some forty named varieties being known) and pigeon peas (*Cajanus indicus*), while in the higher parts of this area field peas (*Pisum arvense*) are to be found.

Observation in the field quickly shows that the use of legumes in indigenous agricultural practice is that of "simultaneous rotation" in the case of all crops, except, as a rule, the Bambara groundnut. Thus on Ukara Island the green manure crop of *Crotalaria striata* (to a less extent an unidentified *Tephrosia* sp. is also used) is sown in growing millet (*Pennisetum*) when that crop is about a foot high, and turned into the ground after the harvest of the millet, during the dry season prior to the sowing of sorghums. Bambara groundnuts are sown in the sorghums just before harvest, and develop and mature as a pure crop [1]. By the Wasukuma and Wanyamwezi, groundnuts, cowpeas and grams are sown in maize or millet with or immediately after the germination of the grain crop, mostly on ridges. Bambara groundnuts are almost always sown alone by the Wasukuma, but may be included by the Wanyamwezi in the general grain/legume mixture described above.

The Bahaya of Bukoba take two crops of beans from the soil of their banana plantations each year. Where the western Bazinza have large banana plantations they adopt the same practice. Thus one finds the same field supporting two permanent crops, bananas and coffee (*C. arabica* or *C. robusta* or both), an annual leguminous undercrop, and frequently, in the more open patches, a maize crop as well, while the vines of yams (*Dioscorea* sp.) are also found throughout the plantations. Bambara groundnuts, how-

¹ SWAHILI SYNONYMS.—Bambara groundnuts, *Njugumawe*; *Crotalaria*, *Malegea*; Groundnuts, *Karanga*; Cowpeas, *Kunde*; Gram, *Choroko*; Kidney Beans, *Maharage*; Pigeon Peas, *Mbaazi*; Field Peas, *Njegere*; *Tephrosia*, *Utupa*; Bulrush Millet, *Mawelee*; Sorghum, *Mtama*; Eleusine, *Ulesi*.

ever, are grown as a pure stand on the less fertile grassland fields where, with long periods of intervening grass fallow, they are rotated with *Eleusine coracana* and "Numbu" yams (*Coleus tuberosus*).

The Baha, Basumbwa and Western Bazinza use a two-part simultaneous rotation. With the early rains kidney beans and maize are sown, together with rather widely scattered pigeon pea. The beans, maturing early, are harvested first, and as soon as they are off the ground (the whole plant is pulled up) sorghum seed is broadcast over the soil. After the maize has been harvested the sorghum and pigeon pea grow on together until about four months later the sorghum is harvested. The pigeon pea goes on alone thereafter, providing a green vegetable during the dry season. Normally pigeon pea is treated as an annual crop, but occasionally, whether accidentally or with intention has not been determined, the crop may be left to grow through a second season as a fallow crop. In the higher parts of this area pigeon pea may not normally be planted, and a slightly different procedure is followed. After the sowing of sorghums on land from which beans have been previously harvested and on which maize is still maturing, further land is broken which, before the end of the wet season, is sown with beans and peas without a grain crop. The same land after the harvest of the beans and peas is normally used for a dry-season plot of sweet potatoes.

Modern experience in tropical agriculture is tending to find scientific benefits in indigenous simultaneous rotation, and it is perhaps of interest to note these systems and particularly the almost invariable habit, under a wide series of possible combinations, of planting Bambara groundnuts only as a pure crop. This is so, though in a modified form, even amongst such experienced agriculturists

as the Wakara, who, circumscribed into the narrow confines of their rocky island at a density of nearly 600 to the square mile, have from their own experience evolved such up-to-date practices as green manuring, stall feeding of cattle, rotations, terracing and the construction of storm drains.

If the use of bananas instead of grains in the food of the people is excepted (and bananas are only in Bukoba a major article of consumption), the greatest difference in the dietary of these several groups of tribes is in the nature of their leguminous crops; and it is perhaps worthy of note, though expressed only as my own opinion, i.e. that of a non-medical man, that it is in the group which grows no oil-seed leguminous crop, e.g. among the Baha, Bazinza and Basumbwa, that the existence of tropical ulcers and quickly festering wounds is most commonly met with.

Attempts to introduce groundnuts into this area, where kidney beans are commonly grown, with a view both to improving the food of the people and to providing an exportable crop in order that their standard of living might be raised, have not met with any great degree of success. It seems reasonable to suppose that, when in nearby tribal areas this crop had come to be of great importance, even before British occupation, it would have been automatically introduced by travellers had the soil or climatic conditions been suitable. While no definite data are available to determine why groundnuts fail to give satisfactory yields, though they apparently grow well enough except for occasional severe attacks of *Cercospora* disease, yet it is suggested that there may be two reasons for this.

The first is the question of soil acidity. In an article entitled "Plant Growth in relation to Hydrogen-ion changes in its

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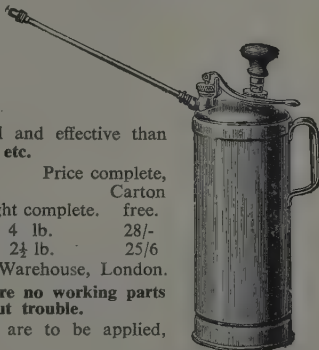
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Medium" [2], B. N. Singh and G. P. Mitra establish that under the conditions in which their experiments were conducted pigeon pea and kidney beans were "typically acid loving"; the optimum pH for the former being found to be 3.4 to 4.4 and for the latter 4.3 to 4.4. On the other hand, sunn hemp (*Crotalaria juncea*) was found to grow best between pH 6.1 and 6.5, and in our local experience this crop has been proved to grow well on the groundnut soils at, for instance, the Ukiriguru Experimental Station in Usukuma.

The second factor is soil texture. Again without detailed knowledge of the soils in this part of Tanganyika it is only possible to make assumptions. Yet basing one's evidence on that of the practical farmer using his eyes, his hands and his stick, the soils of the groundnut areas would appear to correspond closely with those described for other areas in Africa and Asia producing groundnuts in large quantities for export, all of which it would appear could be described as sands or sandy loams, while the soils of the bean districts in the western part of this area under review would be described in English farming parlance as clays or clay loams—heavy or "loving" soils.

Further trials with the object of introducing a leguminous oil seed into this

western area have shown that there are possibilities in the cultivation of the soya bean (*Glycine hispida*). On trial plots satisfactory yields have been obtained, and individual natives who have made use of the bean have applauded its gastronomic possibilities. Trials with more varieties and of the best means of introducing them to native agriculture, and also to native dietary, remain to be made. It is perhaps noteworthy in connexion with the foregoing paragraphs that in the groundnut area little success has been attained with trial plantings of soya.

In conclusion, it is desired to stress the need of careful observation of indigenous uses and practices in the cultivation of the lesser legumes, which play an important, though little noticed, part in native dietary, and which when used as pure crops or in simultaneous rotation may play an essential part in maintaining soil fertility.

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CLAY SOILS

"What is to be done, Sir, with these Clay Siles!—I like 'em—I own I like the strong sile best—but what's the use o' liking what don't pay? The labour's double: everything's double expence on 'em, and the time less to do it in: for drain 'em how you will, you can *not* make winter work on 'em, as you can upon the light. Now don't you confess that?"

"Ah: thereby hangs a long tale! Chemistry on the Light Soils—*Mechanics* on the Clays! When will that great 'Chapter the Second' begin to open? We haven't quite found out everything yet, Greening! There's something *to come*, I suspect, upon the Clays, that will startle you and me—wise as we are—some day. 'A thing to dream of—not to tell.'"

—*Talpa, or the Chronicles of a Clay Farm*, 1835.

THE UNSUITABILITY OF CERTAIN VIRGIN SOILS TO THE GROWTH OF GRAIN CROPS

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Mr. G. Milne, in his notes on the above subject published in September, 1936 (this *Journal*, Vol. 2, pp. 145-148), asked for further examples of the tardiness of virgin soils. No one will deny that information gleaned from natives on a subject that covers a lengthy period of years cannot be taken as infallible, but at least such information, based as it is on evidence obtained from areas wide apart and from numerous individuals, may provoke further correspondence correcting or accepting the views expressed below.

VIRGIN *Miombo* SOILS AND THEIR PERIOD OF FERTILITY

It is to the sandy soils of the *Brachystegia-Isobrerlinia* association to which reference is particularly made. Although there are different types in the succession, the most important and widespread is the *Lusanga* or pale-coloured loamy sand. Apparently five years is the period to which the productive and continuous cultivation of grain crops is limited. After clearing the land and burning, for two years the yield of grain will be very low indeed; so low that though they may plant it with grain, there will be an expectation of crops only from the interplanted legumes, pumpkins and sweet potatoes. Then for five years good grain yields will be obtained, decreasing until the ninth year or so from felling, when root crops are planted until the land is completely worked out. The number of years over which cassava is considered to be productive has not yet been ascertained.

FALLOWS

Natives are of the opinion that short fallows will extend the productivity of

grains by a year or two, but that long fallows of from ten to twenty years are of doubtful value, except on land that was still giving good returns at the time it was retired from cropping. In the latter case, again, the general opinion is that two years, including the year of felling the secondary bush, should be allowed to elapse before planting a grain crop if success is to follow, and even then a good crop is only obtained for a year or two.

If this information is correct, there are enormous areas of young secondary bush in Unyamwezi which are at the present time quite incapable of producing adequate returns of grain crops. It is difficult to ascertain the natives' opinion in regard to the productivity of *Miombo* that has returned after thirty or forty years to an association akin to the original *Brachystegia* fire climax. It is probable, however, that such a soil would be more tardy in producing crops that demand nitrogen than would a soil of virgin woodland, for in this soil type the reserve fertility is too low to support a fully regenerated secondary growth. Mr. Milne refers to this probability in para. 186 of his report (unpublished) on a "soil reconnaissance journey in parts of the Tanga, Eastern, Central, Lake and Western Provinces of Tanganyika Territory." He makes a reference elsewhere to the "over-oxidized and sheet-eroded soil," such as is represented in Tabora by the coppiced long fallows over which grazing cattle roam indiscriminately, and in which cattle tracks often occupy more ground than actual grazing. It is the opinion of the natives that these grazing fallows are even less productive than secondary bush when put under

cultivation again. This singular inability of the "Tabora sand" soils to rehabilitate themselves under secondary bush is not nearly so evident in the *Acacia* savanna.

Questions which arise are :—

- (1) How long does *Miombo* open woodland take to regenerate to its climax and when that stage has been

reached has the soil recovered an ability to produce nitrogen-demanding crops?

- (2) How long can cassava be maintained as a productive crop on worn-out lands?
- (3) Under what conditions do grazing fallows give good returns?

THE DESCRIPTION OF SOILS

"Few things are more difficult, than to give such a description of soils as to convey any accurate ideas to those for whom it was intended. Our language does not furnish words capable of discriminating those nice shades that are of great practical importance. When clay or sand, or loam are mentioned, every person recalls the idea of the soils of the same denomination he has seen; so that if a hundred persons were present, perhaps the word would not convey precisely the same idea to any two of them. One who had seen tough wirey clays, would figure such as these were before him—another has seen clay mixed with a great proportion of sand or gravel.—One has seen clay soils of the poorest and most barren aspect — another understood by that phrase, the most fertile fields he had ever beheld. In short, the diversities are infinite, and the ideas that different persons annex to the same words, are nearly as much diversified.

"There are two opposite extremes of clayey soil; one is of a tough gluey coherent nature, which in the extreme of this sort is called *Till*: The other is of a loose light friable texture, the extreme of which is *Fuller's earth*."

—Dr. James Anderson, 1793.

"As to the Doctor's remark, that 'our language does not furnish words, capable of discriminating those nice shades, that are of great practical importance,' it deserves to be attended to, that wherever men have *clear* ideas, they will generally have *perspicuous* language; and that where these ideas are not only *clear*, but *just* and *correct*, their language will be distinguished by its *precision*. But as our farmers have more generally exerted their *active powers*, than cultivated their *intellectual faculties*, they are more apt to go *wrong* when they use *learned words*, than when they express themselves in the *common language* to which they have been accustomed.—The terms *clay*, *loam*, *sand*, *chalk*, and *peat*, are generally understood, or may be easily explained; and unless our farmers were all regularly educated, and studied chemistry as a science, they would not add to their knowledge, by acquiring a few *technical* expressions to which they did not affix any *clear* or *precise* ideas."

—Rev. Geo. Skene Keith, D.D., *General View of the Agriculture of Aberdeenshire*, 1811.

HILL CULTURE

By Colin Maher, M.A., Dip. Agric. (Cantab.), A.I.C.T.A., Officer in Charge, Soil Conservation Service, Department of Agriculture, Kenya Colony

The rapid loss in fertility that occurs on steep slopes is appreciated even by primitive natives. Steep hillsides may be cultivated for one year only, after clearing the bush, and the land will then be left in bush-fallow for periods varying with the degree of pressure of population upon the land. In the United States, steep lands are commonly "retired from cropping", and are restored to pasture or forest by protection or planting. It is not often that this ideal land-use solution can be applied in East Africa. Population densities in crowded areas may be from 300 to over 1,200 per square mile, and it is not possible to remove people from steep hillsides in such areas owing to lack of more suitable land on which to resettle them. In the circumstances, the best that can be done is to recommend such measures as will slow down the rate of erosion, while still permitting a fair density of population.

The first measure that suggests itself is the construction of bench terraces built on the contour. This form of erosion control has enabled fairly dense populations to cling to hillsides throughout the ages, and all over the world. Traces of stone terracing by more sedentary agricultural tribes who occupied East Africa one or two centuries ago have been found in many parts of the territories. But the construction and maintenance of terraces is laborious and extremely expensive. American experts calculate that terraces on Peruvian mountain-sides represent an expenditure in construction and maintenance by the ancient Incas, over several centuries, which is equivalent to \$18,000 to \$35,000 (£3,600 to £7,000) an acre. Generally, the cost of terracing, except where it is a matter of sheer life-or-death

subsistence, can only be defended where saleable crops of high value can be produced, such as grapes, olives, carobs and figs in the Mediterranean countries, citrus in California, rice in the Philippines.

Moreover, terraces introduce drainage problems which may be difficult of solution. At best, systems of terraces on steep hillsides require constant attention and maintenance if they are not to be destroyed by gullyng. This is especially liable to happen if the terrace lines are not spaced correctly and accurately in the first place.

Some of the difficulties that must be faced in connexion with bench terraces, whether formed gradually by erosion or, by great labour, in one operation, will be discussed in a subsequent article. In the present article I wish to discuss the possibilities of another method of hill culture in which the ecological botanist, the horticulturist and the forester take charge, while the engineer retires into the background.

The philosophy underlying this means of enabling hillsides to be kept under permanent and beneficial occupation in densely populated areas has been set forth in a most interesting manner by J. Russell Smith, now Professor of Economic Geography at Columbia University, New York City, in his stimulating book *Tree Crops*, which was published in 1929 and which deserves a wider public.

Briefly, the idea which Professor Russell Smith has striven to impart is that erosion on hillsides is the disastrous result of growing crops and applying methods of agriculture that are suitable only to plains lands. Annual crops like the grain crops have weak roots which fail to hold the soil, while their cultiva-

tion involves continual loosening of the soil and its exposure to the risk of erosion by running water.

On the other hand, trees have sturdy roots which bind the soil, their culture does not necessitate frequent breaking of the soil, and they are better adapted with their wide-searching root systems to resist drought and to take advantage of all the rain that falls. Trees will often flourish on shallow soil, thrusting their roots deep into niches in the rocks. This is not all. The resources of vegetative reproduction are available for use in multiplying single "sports" or hybrids of trees with valuable characteristics, while with annual crops it is necessary laboriously to breed seeds that will come true to type.

The problem then is to collect, test, select, and multiply valuable tree and bush crops and perennial plants, both indigenous and exotic. These crops may provide shelter from wind, fuel, timber, economic products such as drugs, tannins, essential oils, fibres or dyes, food for man in the form of fruits or nuts, or food for animals in the shape of pods, fruits or forage.

The possibilities of our local trees and shrubs for medicinal and food purposes have not been fully explored by the different specialists concerned, nor has sufficient attention been paid to our indigenous *Acacia* sp. and other trees and browse plants which supply food for animals in the semi-arid parts of East Africa. Much traditional lore of plants amongst the native tribes, handed down by word of mouth from father to son, is becoming lost as the younger generation receives a smattering of our Western knowledge at school in place of the old family instruction in economic botany. We should rescue and utilize this native learning before it is lost for ever.

In the matter of food plants, we have sufficient knowledge of fruits and nuts to

make a fairly long list of woody plants and perennials that will grow satisfactorily in various parts of East Africa, though no one would suggest that, beyond issuing a few thousand trees of various species, we have gone far in the introduction of tree-culture as a means of life of natives living on the hills. Such a list might read as follows:—

Food Plants—

Pawpaw, Avocado, Orange, Lemon, Grape Fruit, Lime, Mango, Peach, Plum, Fig, Date, Oil Palm, Coco-nut, Almond, Guava, Banana, Olive, Mulberry, Loquat, Grape, Pomegranate, Passion Fruit, Jack Fruit, Carob Bean, Cashew Nut, Soursop, Sweetsop, Carambola, Durian, Litchi, Rambutan.

Economic woody plants, other than food plants, include—

Coffee, Tea, Ylang Ylang, Areca Nut, Tung Oil (*Aleurites fordii* and *A. montana*), Kapok, Cinchona, Rubber, Tara Bean, Nutmeg, Clove, Cinnamon.

These lists by no means exhaust the possibilities of trees and woody plants which might be grown on hillsides. I have mentioned olives in the list, but it is uncertain whether this crop has yet been grown successfully in East Africa. It would seem likely that success might be attained if imported commercial budwood were grafted on to indigenous olive stocks. In South Africa the European olive has been budded successfully on to *Olea verrucosa*, a wild olive which occurs throughout the Union of South Africa, the Kalahari, Southern Rhodesia and Portuguese East Africa. Incidentally, *Olea verrucosa*, which was imported by the Kenya Department of Agriculture in April, 1937, provides, like the Kenya olive, durable and handsome timber and excellent fence posts, while the seed, leaves and twigs are eaten by almost all herbivorous animals.

During the last few years the Department of Agriculture, Kenya Colony, has made trials of fodder trees at Machakos and Rongai. A trial at Naivasha was a failure, but a new fodder tree arboretum was started at the end of 1938 near Narok in the Masai Reserve, while fodder trees are being included in a trial of fodder crops on Mr. Thompson's farm at Nanyuki.

A report made by the Officer in charge of Grassland Improvement on the progress of the Machakos and Rongai trials of fodder trees and shrubs to September, 1938, dealt with species of *Brachychiton*, *Eucalyptus*, *Phytolacca*, *Disperma*, *Celtis*, *Acacia*, *Prosopis* and *Casuarina*, and showed that at Machakos all made fair growth except *Prosopis juliflora* and *Casuarina stricta*. *Disperma trachyphyllum* grew strongly, seeded prolifically, and afforded a complete ground cover. Australian salt-bush and spineless cactus were both making good growth. At Rongai only the *Casuarina* and *Eucalyptus microtheca* managed to withstand the conditions; the majority of the others succumbed either to drought or to the ravages of buck (this in spite of a wire-and-netting fence).

Trials of *Acacia giraffae*, *Olea verrucosa* and *Zizyphus mucronata* are in progress at Nanyuki, the seed having been obtained from Pretoria.

In addition to the trees and bushes which have already been mentioned, a few notes may be given on other plants which have been tried in the Colony.

The Old Man Salt Bush (*Atriplex nummularia*) and the Creeping Salt Bush (*A. semibaccata*) have been grown in the Kamasia Reserve for several years. These browse bushes grow well (Old Man Salt Bush reaching a height of five feet) and are relished by stock.

The Bottle Tree or Kurrajong (*Brachychiton populneum*), a noted Australian

fodder tree, has made excellent growth in many parts of the Colony, including Nairobi, Kitale, Endebess, and the Kamasia Reserve.

Spineless Cactus has a strong adherent in Mr. Hodgson of Athi River, who has grown it for many years. This fodder plant is also under trial at Nanyuki, in the Kamasia Reserve, and other native areas.

Karoo Bush (*Pentzia incana*) and the browse plants *Tetragonia Arbuscula* and *Tripteris pachypteris*, were obtained from the Department of Agriculture, Pretoria, at the end of 1938, and are under trial at Machakos, Rongai and Nanyuki.

SUGGESTIONS FOR FURTHER TRIALS

Prosopis juliflora, the Mesquite, Honey Locust, Algaroba or Keawe, has shown great promise at Taveta, where some seeds imported by Major E. S. Grogan from Honolulu were planted three or four years ago. This fodder tree is of high value in Hawaii, to which country it is thought it was brought from South America. There are said to be eighteen or more species of *Prosopis*, which occurs from Texas to Chile, and also in the West Indies, Argentine, Ecuador, Peru, Bolivia, and Paraguay. It thrives best at low altitudes, though in Hawaii it is found up to two thousand feet. The New Mexico, Arizona and Texas species are rather slow-growing, and the Hawaiian plant is likely to give better results in East Africa. Prof. Russell Smith recommended to the writer that a culture of the appropriate root bacteria for inoculating these trees should be obtained from Hawaii.

The algaroba wood is good for fuel, and the smaller branches for charcoal. The bark contains tannin and the gum is suitable for the manufacture of varnish. However, the chief use of the tree is as a forage crop. The beans are eaten and

relished by chickens, pigs, horses and cattle. The yield per acre has been found to vary from two to ten tons. Meal made from the ground pods is considered in Hawaii to be equal to barley and oats for feeding purposes.

The tree has the fortunate characteristic of being able to thrive in barren, dry and rocky land which otherwise would have no value. On one ranch in Hawaii it is said that an acre of good algaroba trees will fatten at least six head of cattle, raising their weight two hundred pounds in ninety days. This is in country with a rainfall of only twenty inches.

Ceratonia Siliqua (the Carob, Carob Bean, Algaroba, or Locust Bean).—This tree has been tried with varying success in Kenya. Attempts at budding trees in the Nairobi Arboretum and seedling trees at the Scott Agricultural Laboratories with bud-wood imported from Cyprus, where carobs are an important crop, have hitherto resulted in failure. However, Mr. J. W. Newton of Turbo has some seedling carob trees which have been bearing heavy crops.

The carob is used for forage for heavy draft animals, and less extensively as forage for sheep, goats, cows and pigs. The finer varieties of bean are sometimes ground and used with wheat flour for human food, while Russell Smith states that "cereal food," candy and syrup have been made from the beans in California. The bean is said to contain 24 per cent protein and 47½ per cent carbohydrate.

Gleditschia triacanthos, the Honey Locust, is suited to climates in which maize and cotton will grow; but it will grow also in fairly arid country with a rainfall as little as 20 or 25 inches; indeed, it is recorded as having done well, without irrigation, under a rainfall of

fourteen inches in Colorado and sixteen inches in Western Nebraska. This leguminous tree gives good timber, and a tree may produce twenty bushels of pods, which are devoured greedily, whole, by cows and pigs.

I have mentioned the possibility of greater use of indigenous East African *Acacia* sp., such as *A. pennata*, *A. spirocarpa* and *A. seyal*, the pods of which are eaten by stock in the dry weather. It is highly probable that investigation would reveal many indigenous trees and bushes worthy of attention for hill culture, and to provide a forage reserve in the more arid parts of East Africa. Seed of these trees might be scattered to replace valueless bush.

India, Australia, Rhodesia, and Brazil also might prove to be sources of valuable leguminous fodder trees for use in East Africa.¹

Browse plants indigenous to the United States which are worth trying in certain areas are the following:—

Grayia spinosa.—Hop-sage; excellent forage for sheep.

Atriplex sp.—Shadscale; good forage for sheep.

Artemisia frigida.—Fringed sage bush; helpful in preventing erosion and a good forage plant.

Pershia tridentata.—Antelope Brush; highly prized for cattle and sheep, since it produces solid fat in the animals.

Artemisia tridentata.—Big Sage Brush; a good forage bush, especially in Utah and Nevada, and will stand heavy grazing.

Balsamorhiza sagittata.—Arrow-leaved Balsam Root; has excellent forage value and grows on poor, rocky soil.

¹ During certain periods of the year the Indian cowkeepers in Mauritius feed their milch cows almost entirely on clippings from *Leucaena glauca*, which is found growing everywhere on uncultivated land.—Ed.

Anisacanthus Thurberi. — Desert Honeysuckle; an Arizona browse plant for cattle.

These and other American desert plants deserve trial in that they are accustomed to arid conditions and extreme summer heat, although it is not known how they would react to a climate in which they would not have to suffer a winter.

TECHNIQUE OF TREE-CULTURE ON HILLSIDES

The use of trees on steep hillsides to preserve the soil and to provide food for man and beast is worthy of the provision of special experimental and demonstrational areas in various parts of East Africa under different climatic conditions.

In general, contour planting is necessary, while rough contour walls of stones could be constructed in some districts. Failing the provision of contour banks or walls, a series of silt pits would assist to conserve water and enable it to soak down to the tree roots.

Many of the fodder trees such as the Bottle Tree and the Portuguese Elm are at their best when growing near a river side, and these trees probably would do best if planted along the sides of the larger gullies and watercourses on the hill slopes.

In arid districts trees are generally found in natural depressions or near watercourses, where they obtain additional moisture. For this reason, whether on relatively flat land or on hillsides, in arid districts it will be found best to plant fodder trees behind contour banks designed to hold water, while it may be possible to divert road drainage water or other surplus run-off to add to the supply.

It should be feasible to work out systems of agriculture for use on hillsides at various altitudes and with different aver-

age annual rainfalls, in which food for man and beast would be derived almost entirely from woody or perennial crops. This vegetation would conserve the soil and allow of permanent occupation of the hill slopes.

Belts of Napier grass¹ (*Pennisetum purpureum*) grown for cattle fodder on the moister hills would be substituted on the more arid slopes by spineless cactus (*Opuntia* sp.), *Agave americana*, Old Man Salt Bush (*Atriplex nummularia*) and other drought-resistant bushes and plants, with a second story of pod-bearing *Acacia* sp., mesquite and other fodder trees.

The people would depend largely for food on the fruit- and nut-bearing trees that have been mentioned earlier, exchanging surplus amounts of these food-stuffs for grain grown by natives on flatter land on the plains below the hills. Some of the tree crops, like almonds and olives, would have a value for cash sale; others would afford the raw materials for the extract of oils, tannins, dyes, or perfumes, for canned juices and fruits.

The possibilities are vast, but a study of the collection of plants that are under trial by the Hill Cultures Section of the Soil Conservation Service of the United States Department of Agriculture, to which I am indebted for the appended list, suggests that this work could not be treated as a side-line, but that the collection and examination of indigenous and exotic perennial tree-crops and other perennial bushes and plants of economic value would constitute full-time employment. The collection of species and the examination of eventual results is a large task in itself, but continual study is necessary also in order to facilitate subsequent selection and breeding work, together with experimental work on cultural techniques and methods of use of the plant products.

¹ Napier grass = Elephant grass.—Ed.

LIST OF PLANTS

Name of Plant	Popular Name	Purpose
<i>Pinus Parryana</i>	Nut-pine	Edible nut, timber.
<i>Quercus deciduus</i>	Oak	Acorns for fodder.
<i>Quercus agrifolia</i>	Oak	Acorns for fodder.
<i>Umbellularia californica</i>	California laurel	Shade tree.
<i>Castanea mollissima</i> .. .. .	.. .. .	Edible nut.
<i>Prunus Lyonii</i>	Islands cherry	Fruit.
<i>Prunus ilicifolia</i>	Wild cherry	Fruit.
<i>Prunus Armeniaca sibirica</i>	Apricot	Fruit.
<i>Simmondsia californica</i>	Pig nut	Oily seed and edible fruit.
<i>Ilex cornuta</i>	Holly	Decorative.
<i>Ilex Aquifolium</i>	English holly	Decorative.
<i>Ilex Aquifolium fertilis</i>	English holly	Decorative.
<i>Pistacia vera</i> var. <i>Aleppo</i>	Pistachio	Edible nut.
<i>Pistacia vera</i> var. <i>Bronte</i>	Pistachio	Edible nut.
<i>Pistacia vera</i> var. <i>Kaz</i>	Pistachio	Edible nut.
<i>Prosopis</i> sp.	Mesquite	Fodder.
<i>Ceanothus</i> sp.	Ceanothus	Decorative.
<i>Juglans californica</i>	Walnut	Edible nut.
<i>Pentzia incana</i>	Karoo-bush	Browse plant.
<i>Acacia</i> sp.	Acacia	Fodder.
<i>Zizyphus Jujuba</i>	Jujube	Fruit.
<i>Gleditschia triacanthos</i>	Honey locust	Fodder.
<i>Diospyros Kaki</i>	Persimmon	Fruit and fodder.
<i>Rhus</i> sp.	Sumach	Tannin.
<i>Photinia arbutifolia</i>	Tollon	Fruit.
<i>Hicoria Pecan</i>	Pecan	Edible nut.
<i>Castanopsis sempervirens</i> .. .. .	.. .. .	Edible nut.
<i>Castanea Seguinii</i> .. .. .	.. .. .	Edible nut.
<i>Corylus rostrata</i>	Hazel	Edible nut.
<i>Corylus americana</i>	Hazel	Edible nut.
<i>Elaeagnus multiflora</i>	Gurni	Fruit.
<i>Myrica rubra</i> .. .. .	.. .. .	Fruit.
<i>Juglans nigra</i>	Black walnut	Edible nut.
<i>Juglans Hindsii</i>	Walnut	Edible nut.
<i>Juglans boliviana</i>	Walnut	Edible nut.
<i>Juglans Sieboldiana</i>	Walnut	Edible nut.
<i>Pinus monophylla</i>	Pine	Timber.
<i>Castanea hybrids</i> .. .. .	.. .. .	Fruit.
<i>Diospyros virginiana</i>	Common persimmon	Fruit and forage.
<i>Olea</i> sp.	Olive	Fruit.
<i>Ficus</i> sp.	Fig	Fruit.
<i>Morus</i> sp.	Mulberry	Fruit.
<i>Ceratonia Siliqua</i>	Carob	Forage.
<i>Robinia Pseudacacia</i>	Black locust	Timber.
<i>Albizia kalkora</i> .. .. .	.. .. .	Ornamental.
<i>Paulownia Fortunei</i> .. .. .	.. .. .	Ornamental.
<i>Cedrela sinensis</i> .. .. .	.. .. .	Ornamental.
<i>Eisenhardtia</i> sp. .. .. .	.. .. .	—
<i>Torreya californica</i>	Californian nutmeg	—
<i>Punica granatum</i>	Pomegranate	Fruit.
<i>Feijoa Coolidgei</i>	Feijoa or pineapple guava	Fruit.
<i>Eugenia uniflora</i>	Pitanga or surinam cherry	Fruit.
<i>Macadamia ternifolia</i>	Queensland nut	Fruit.
<i>Mammea americana</i>	Mammee apple	Fruit.
<i>Amygdalus communis</i>	Almond	Edible nut.
<i>Aleurites Fordii</i>	Tung oil	Oil nut.

LIST OF PLANTS—(Contd.).

Name of Plant	Popular Name	Purpose
<i>Yucca baccata</i>	Yucca	Fruit.
<i>Agave</i> sp.	Sisal	Fibre.
<i>Aloe</i> sp.	Aloes	Drugs.
<i>Argania spinosa</i>	—	—
<i>Lyonothamus floribundus</i>	Lyon shrub	Ornamental.
<i>Pyrus kawakami</i>	—	Fruit.
<i>Quillaja Saponaria</i>	Soap-bark tree	Alkali.
<i>Cratægus Arnoldiana</i>	Hawthorn	—
<i>Chænomelos</i> sp. and var.	Quince	Fruit.
<i>Sambucus</i> sp. and vars.	Elder	Fruit.
<i>Prinsepia sinensis</i>	—	Oil from seeds.
<i>Carissa grandiflora</i>	Natal plum	Fruit, hedge plant.
<i>Berberis Nevinii</i>	Barberry	Fruit.
<i>Cratægus pinnatifida</i>	Hawthorn	—
<i>Cratægus Laota</i>	Hawthorn	—
<i>Xylosma senticosum</i>	—	—
<i>Viburnum americanum</i>	—	Ornamental.
<i>Arctostaphylos glauca</i>	Manzanita	Ornamental.
<i>Cudrania tricuspidata</i>	Silkworm thorn	Edible, hedge plant.
<i>Phellodendron</i> sp. (Velvet tree)	Velvet or cork tree	Ornamental.
<i>Prunus Besseyi</i>	Western sand cherry	Fruit.
<i>Ephedra</i> sp.	Ephedra	Drug.
<i>Actinidia chinensis</i>	(Climbing shrub)	Fruit.
<i>Actinidia arguta</i>	(Climbing shrub)	Fruit.
<i>Vitis</i> sp.	Grape	Fruit.
<i>Rubus parvifolia</i>	Cork oak	Cork.
<i>Acacia deliens</i>	—	Fodder, tannin.
<i>Acacia Cavenia</i>	Espino cavan	Tannin, hedge plant.
<i>Acacia Farnesiana</i>	Popinac	Perfume.
<i>Mayer lemon</i>	—	Fruit.
<i>Rangpur lime</i>	—	Fruit.
<i>Hibiscus Saccarifia</i>	Roselle	Fruit.
<i>Chrysanthemum cinerariæfolium</i>	Pyrethrum	Flowers.
<i>Leucaena glauca</i>	—	Fodder.
<i>Phormium tenax</i>	New Zealand flax	Fibre.
<i>Crotalaria juncea</i>	Sunn hemp	Fibre.
<i>Acacia Berlandieri</i>	—	—
<i>Portieria angustifolia</i>	—	—
<i>Tilia phanera</i>	—	—
<i>Stachys Drummondii</i>	Hedge nettle	—
<i>Fremontia mexicana</i>	—	—
<i>Arbutus Andrachne</i>	—	—
<i>Baccharis pilularis</i>	—	Ornamental.
<i>Baccharis pedicularis</i>	—	Ornamental.
<i>Eriogonum fasciculatum</i>	—	Ornamental.
<i>Eriogonum grande</i>	—	Ornamental.
<i>Eriogonum rubescens</i>	—	Ornamental.
<i>Eriogonum cinereum</i>	—	Ornamental.
<i>Atriplex semibaccata</i>	Creeping salt bush	Browse plant.
<i>Atriplex confertifolia</i>	—	Browse plant.
<i>Galium angustifolium</i>	Bedstraw	—
<i>Galium Nuttallii</i>	Bedstraw	—
<i>Hymenanthera crassifolia</i>	—	Ornamental.
<i>Chamaebatia foliolosa</i>	—	Ornamental.
<i>Eriodictyon californica</i>	—	Ornamental.
<i>Echium Wildpretii</i>	Viper's bugloss	Ornamental.

LIST OF PLANTS—(Contd.).

Name of Plant	Popular Name	Purpose
<i>Kennedya Comptoniana</i> .. ..	.. .. .	Ornamental.
<i>Sanguisorba minor</i> .. ..	.. .. .	Ornamental.
<i>Fragaria chilensis</i>	Wild strawberry	Fruit.
<i>Perifolia virgata</i>	—	—
<i>Jasminum imprimulatum</i>	Jasmine	—
<i>Artemisia californica</i>	—	—
<i>Artemisia Dracunculus</i>	Tarragon	Seasoning.
<i>Salvia</i> sp.	Sage	Herbs.
<i>Centrosema virginianum</i> .. ..	.. .. .	Ornamental.
<i>Lotus scoparius</i>	—	—
<i>Lotus argyophyllus</i>	—	—
<i>Mesembryanthemum</i> sp. .. ..	.. .. .	Erosion control.
<i>Sedum alpinum muralis</i>	Orpine or stone crop	Erosion control.
<i>Lippia repens</i>	Verbena	—
<i>Rumex hymenosepalus</i>	Dock	—
<i>Euphorbia</i> sp.	—	—
<i>Mentha</i> sp.	Mints	Essential oil.
<i>Cytisus scoparius</i>	Scotch broom	Medicinal.
<i>Lotus corniculatus</i>	Birdsfoot trefoil	Forage.
<i>Desmodium</i> sp.	Tick trefoil	Forage.
<i>Burbank cactus</i> .. ..	.. .. .	Forage.
<i>Cneoridium</i> sp.	—	—
<i>Rubia tinctorum</i>	Madder	Dye.
<i>Acacia verticillata</i>	Whorl-leaved acacia	Hedge plant.
<i>Nicotiana glauca</i>	Wild tobacco	—

[The following notes have been supplied by the Acting Conservator of Forests, Kenya Colony, as a supplement to the article "Hill Culture" by Mr. C. Maher.—ED.]

KENYA TREES YIELDING EDIBLE PRODUCTS

Kenya is not very well supplied with indigenous trees that provide food for man or fodder for animals. There are, however, various edible fruits, while goats will eat the forage of almost any species. The following list indicates the extent of present knowledge.

Acacia spirocarpa.—The fruits are fed to cattle in the Lamu district.

Eugenia Jambolana.—This is not an indigenous plant, but has become naturalized on the coast, and is grown in the Kisumu district. The fruits are eaten by man.

1. PLANTS THAT PROVIDE FOOD FOR MAN OR BEAST AND ARE TO BE FOUND IN NATIVE MARKETS.

Tamarindus indica.—This is not indigenous, but has become naturalized on the coast. The fruits are eaten by man.

2. PLANTS THAT PROVIDE EDIBLE FRUITS IN FAIR QUANTITY, BUT WHICH ARE NOT, AS FAR AS IS KNOWN, MARKED.

Dovyalis abyssinica.

Dovyalis macrocalyx.

Vangueria sp.

Flacourtia Ramontchi.

The Cycad, *Encephalartos Hildebrandtii*—a staple food of the Waboni, west of Lamu, in dry seasons.

Myrianthus arboreus.—Fruit said to be useful to man.

3. EDIBLE FRUITS WHICH NORMALLY ARE PRODUCED IN SMALL QUANTITIES, BUT WHICH ARE OF DOUBTFUL VALUE.

Chrysophyllum glomeruliflorum.

Pachystela brevipes.

Landolphia sp.—Climbers, giving fruits and rubber.

Carissa edulis.

Some *Canthium* sp.

Annona chrysophylla.

Garcinia Livingstonei.

Some *Grewia* sp.

Antidesma venosum.

Rubus sp.

Ximenia americana.

4. PLANTS GIVING MISCELLANEOUS ECONOMIC PRODUCTS.

Catha edulis.—An aphrodisiac for which there is apparently an established market.

Balanites ægyptiaca.—The fruits contain an oil of some value.

Conopharyngia Holstii, *Periploca linearifolia*.—The latex of these species is said to be fed, mixed with other fodder, to milch cows.

Terminalia catappa (Indian Almond), *Anacardium occidentale* (Cashew Nut), *Mangifera indica* (Mango),

Moringa pterygosperma (Horse Radish Tree).—Useful trees naturalized in the coast districts, and which are well known.

Cluytia abyssinica.—This is said to be excellent fodder for goats, and possibly might be suitable for sheep, though this is not known.

Debera Roxburghii, *Salvadora persica*, *Clausena anisata*.—These plants provide "toothbrush sticks," for which there is an established market.

Zizyphus jujuba.—The fruits are edible. A brown dye is obtained from the plant which is, incidentally, a host plant for the lac-insect, while the sandalwood tree in India establishes itself upon *Zizyphus jujuba* as a parasite.

The Masai are believed to use the fruits of a plant, which probably belongs to the *Capparadaceae*, as cattle fodder in dry years. The "cabbages" of some coastal palms are eaten, though it is more common for the plants to be tapped in order that the sugary sap may be fermented to form toddy.

Doubtless there are other edible fruits or fodder plants which have not been mentioned above. Few of the aforementioned plants appear worth growing if more useful exotics are available or will thrive.

[In addition to the above plants, it is known, for example, that cattle and goats feed on the pods of *Acacia pennata* and *Acacia seyal*, and probably others. It is possible that some of the plants mentioned in the above list provided by the Acting Conservator of Forests might be susceptible to improvement by selection and plant-breeding methods.—C.M.]

NOTES ON FEEDING

By R. S. Ball, M.A. (Cantab.), Dip. Agric. (Cantab.), A.I.C.T.A, Agricultural Officer,
Department of Agriculture, Kenya Colony

The somewhat irregular nature of the rains and the poor growth of grass in many areas has caused some anxiety amongst stock farmers and has necessitated a review of the feeding position for the coming months. It is doubtful whether any large reserve of grass will now be available for the dry periods likely to be experienced in the coming months, and the position is further rendered difficult in many areas by the possibility of locust infestations. In order to guard against these, it will be desirable to plant those forage and fodder crops which are least likely to be damaged by these pests, and although the range of such is limited yet there are several which will probably not be severely affected. The most important of these is sunflower, and, in addition, there are others such as the bulk of the leguminous crops, including vetches, peas, etc., all of which are likely to suffer a minimum amount of damage.

It is interesting to note that increasing use is being made of sunflower in this country, and reference was made in a previous note on feeding to the value of this crop, which can either be ensiled or the leaves fed green, or alternatively harvested for seed, the seed and heads being ground up together into a meal to be used in concentrate mixtures. Figures of analysis show the relatively high feeding value not only of the seed but also of the heads themselves.

The leaves of the growing plant, picked and fed green, are also useful in helping to keep up the milk supply during a period of shortage.

A certain number of farmers are likely to be using sprouted grain as a sup-

plementary feed during these adverse periods, and it should be noted that it is essential to avoid feeding this food in a mouldy condition, as it may cause a taint in the milk which will lead to degrading of the cream. It is at the higher elevations and under conditions of low night temperature that these moulds are likely to develop, when growth of the grain is slow and possibly rather irregular. The use of good sound grain only for sprouting, in stores which are kept thoroughly clean and not used for other purposes such as storing potatoes or other perishable produce, will go a long way towards the prevention of the spread of these moulds.

The cultivation of potatoes may be justified this year on farms where locust infestations are likely to occur, and if these are not saleable at a remunerative price they can be used as a cattle food. Their succulent nature renders them of considerable value, and they can be fed raw to milking cows in quantities of 15 to 20 lb. daily. They should not be cooked for cattle feeding, and should be washed before feeding if they are in a dirty condition. They can also be used for young rearing stock over six months, but are chiefly valuable as a succulent food for helping to maintain the milk supply. They should not be fed in large quantities at one time, and 15 to 20 lb. daily suggested for milking animals should be divided into two feeds. Some farmers prefer to chop or pulp them before feeding, but this is not necessary as long as they are fed in clean condition. Potatoes with long sprouts should not be fed, but these should first be rubbed.

Pig Feeding.—With increasing supplies of skim milk available as the result of the

rains, pig feeders will be able to economize in the quantity of meals fed to their fattening stock and to reduce the amount of protein fed in these meals. It is important to note that the bulk of the skim milk should be fed by itself and the meal ration mixed to a stiff paste with skim milk. Feeding of very liquid milk in large quantities is not desirable, since the pigs simply dredge the meal out from the liquid and it is likely to make them pot-bellied and to impair their digestions. They will consume their skim milk ration much more readily if it is fed after the meal ration is finished and cleared up.

Since pollards and bran are difficult to obtain at the present time, pig feeders are in some cases anxious to know what they can use as substitutes. While there are no real substitutes for these feeds, yet a balanced ration composed of barley meal, maize meal and pea-meal, together with

skim milk, will enable high quality pigs with firm fat to be produced, even if these feeds are not available. In the absence of skim milk, however, it is difficult to replace them, but an increased quantity of barley meal should be substituted for maize so that the latter does not constitute more than 40 per cent of the ration of the fattening pigs, and pea meal or other suitable vegetable protein should be fed to the extent of 15 per cent of the ration.

There is a tendency in this country to overfeed in-pig sows, and in many cases the dry sows are too fat, with the result that small litters and small pigs are produced. Generally, the sow, unless in poor condition, can be cheaply fed when dry, and then ten days prior to farrowing should be put on a meal ration of 8 to 10 lb. daily, in which bran is present to the extent of ten per cent of the total.

CULTIVATORS FOR MAIZE

From statistics supplied by two of the leading agricultural warehousemen in Nairobi, it appears that spring- and rigid-tine cultivators have for some years been losing their popularity with maize growers. No doubt many derelict machines have been repaired during the years of depression, when in the normal course of events they would have been discarded and new ones bought. But whereas in 1924 more tine cultivators than disc harrows were purchased, to-day the ratio is estimated at one tine cultivator to fourteen disc harrows.

Farmers know the value of the disc harrow in preparing a seed-bed, especially on newly broken land and when working old land before the rains begin; but the weight of tropical rain pounds down

some soils to such an extent that they become unfit for planting. If the disc harrow is used on land in this condition, weeds may be destroyed but the land is compacted. This is not the best type of seed-bed for maize. If, instead of the disc harrow, an implement is used that will lift up the soil as well as destroying most of the weeds, a perfect seed-bed for maize will result.

In East Africa the time and method of planting maize varies according to soil, rainfall and individual preference, but where tractors of 20 to 30 h.p. are still employed, the combination of tine cultivator and maize planter will be found most useful, especially in wet weather.

—Note contributed by W. C. Clarke, Agricultural Assistant, Tanganyika Territory.

SOIL CONSERVATION IN PYRETHRUM FIELDS

By the Soil Conservation Service, Department of Agriculture,
Kenya Colony

PREPARATION OF THE LAND

Much of the new pyrethrum land is virgin sod. The practice of burning off the grass before beginning to plough, presumably in order to make breaking more easy, is to be deprecated. This practice is destructive of organic matter which otherwise would benefit the soil by raising the nitrogen content, increasing its permeability to moisture, and decreasing its erodibility and tendency to dry out.

This is not the only result from this ill practice of grass burning. Should the farmer fail to burn or cut out a firebreak around the site of the proposed pyrethrum field, the fires lit to burn off the grass may spread far and wide into pasture-land and woodland.

Running grasses or "couches" of course must be burnt in heaps when clearing old fields of these dangerous weeds. It is appreciated that there are circumstances such as in breaking land upon which the grass has not been burnt for several years, when it may be almost impossible to plough if the mat of dead grass is not first removed by burning.

TERRACING—GENERAL

The most suitable method of erosion control for pyrethrum fields is a form of broad-base terracing. Terraces may be constructed for pyrethrum on slopes up to 20 per cent. This upper limit is in fact a very steep slope, and it would be necessary to use more elaborate and costly measures, such as bench terracing, on steeper slopes than this. Where possible, cultivation of pyrethrum should be confined to land no steeper than 12 or 15 per cent.

The type of terracing which is described below should not cost more than

Sh. 5 an acre. On Messrs. Barnes' farm at Ainabkoi, terracing the pyrethrum fields cost Sh. 3/75 an acre, inclusive of hand labour but exclusive of the cost of European supervision. These terraces were made by a Martin ditcher pulled by oxen, and successfully withstood a fall of two inches of rain in twenty minutes. The task for banks constructed by hand is from ten yards to fifty yards a day per boy, according to the nature of the soil.

In view of the benefits to be obtained and, conversely, the deterioration of the crop and the land which will ensue if this measure is neglected, the cost of terracing is negligible, especially in relation to the high returns which are now being obtained from pyrethrum.

Unplanted fields offer no difficulty. There should be no delay in terracing old fields of pyrethrum, however; sheet erosion does not await convenience. Terracing established pyrethrum fields can be done by digging up the pyrethrum from a strip, ten or twelve feet wide, of which the pegged line is the centre. The terracing can then be carried out and the banks and channels of the finished terraces can be planted, when climatic conditions permit, with splits from the old plants.

SETTING OUT TERRACES

Terraces can be set out conveniently, with pegs every fifty feet (or closer at curves), with a level and a "Barnes" terracing staff. Blue prints showing the construction of these staffs can be obtained from the Department of Agriculture; staffs are made by Messrs. Isherwoods, Nairobi, and Messrs. Turner, Barker and Hatfield, Kitale. Terraces should not drain more than 1,200 feet in any one direction, and



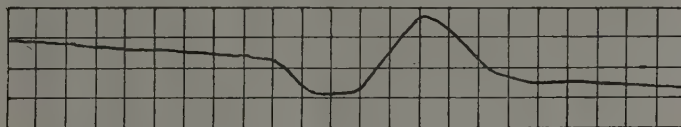
Terraced Pyrethrum—No. B 2, Ainabkoi



Terraced Pyrethrum—No. 50, Ainabkoi

TYPICAL CROSS-SECTIONS OF TERRACE CONTOUR BANKS, TAKEN FROM MEASUREMENTS IN ACTUAL FIELDS WHERE THEY HAVE STOOD UP TO RAINS OF 1.9 AND 2.07 IN 20 MINUTES (IN THE CASE OF SECTIONS B, C, D, E).

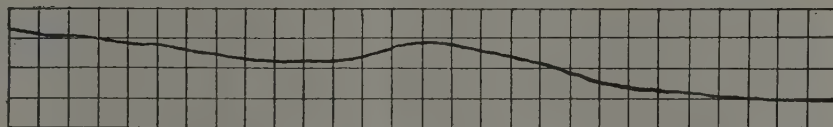
Note.—All banks were made from the upper side only, except on flat slopes, as in the case of B, where some earth may be drawn from the lower side.



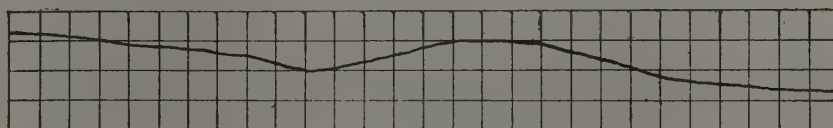
A.—The wrong section of bank. It is too steep, and is soon broken down by heavy rain and weeding. This type of bank is not suited to planting.



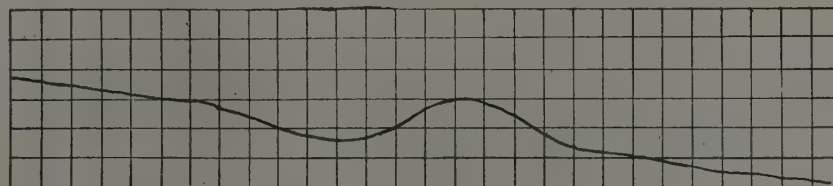
B.—Flat bank on easy slope, 3.6 per cent. The rows of pyrethrum are planted on the bank and in the channel. This applies to sections B, C, D, E.



C.—Bank on 8 per cent slope. The cross-section of the channel should give a minimum of 5 square feet water capacity where banks are 700 feet long and 8 square feet on banks up to 1,200 feet long.

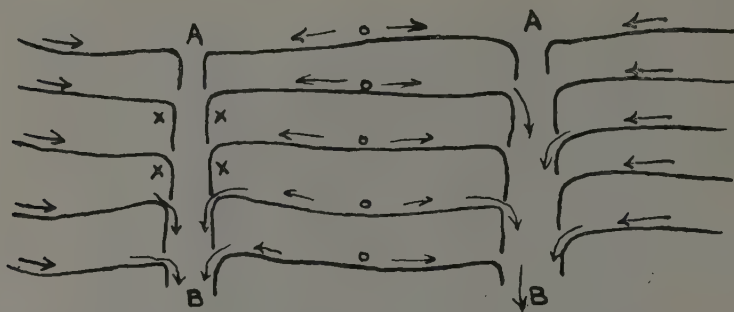


D.—Bank on 6.6 per cent slope. Banks B, C and D have been in use for three years. Note how the channels have flattened out.

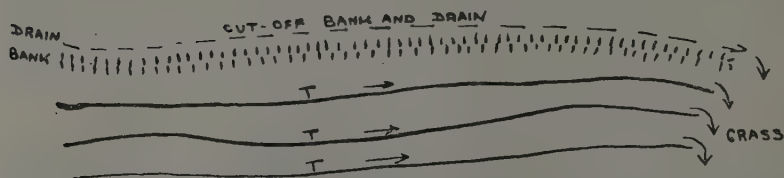


E.—Bank on 12 per cent slope. Upper side of channel has not flattened out in its second season. In weeding always work drawing the soil up the bank, so that the bank is not broken down. At intervals during the year draw any silt that may have collected in the channel up on to the bank and back into the field uphill.

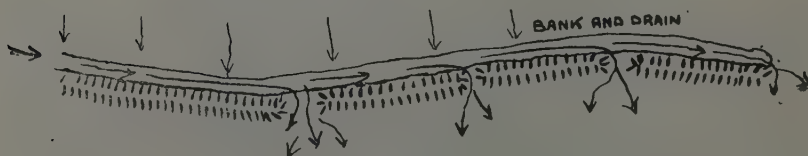
Note.—Scale, all sections: Each square equals one foot.



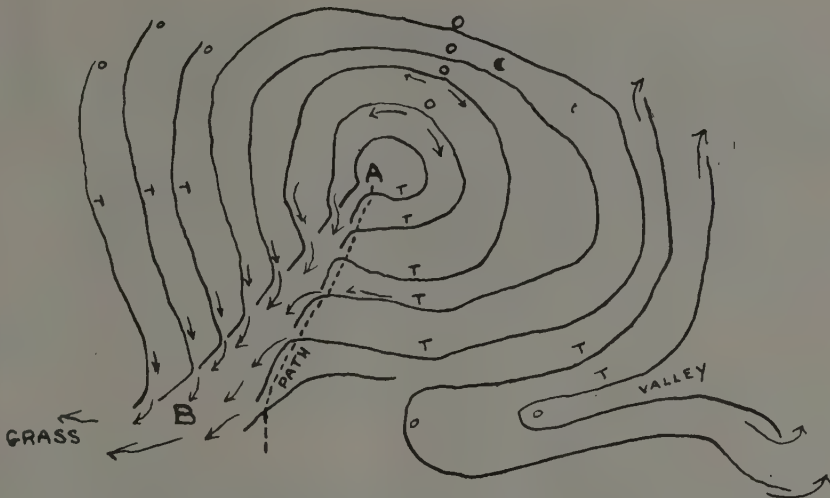
Terraces on a long field where the field has to be split into sections and water is led out from terraces into grassed outlets A B. The sides of outlets are protected by grassed banks X X made by earth borrowed from inside the field; earth must not be borrowed in the outlets, which are levelled, grassed and protected. For size of outlets see table of dimensions and acreages.



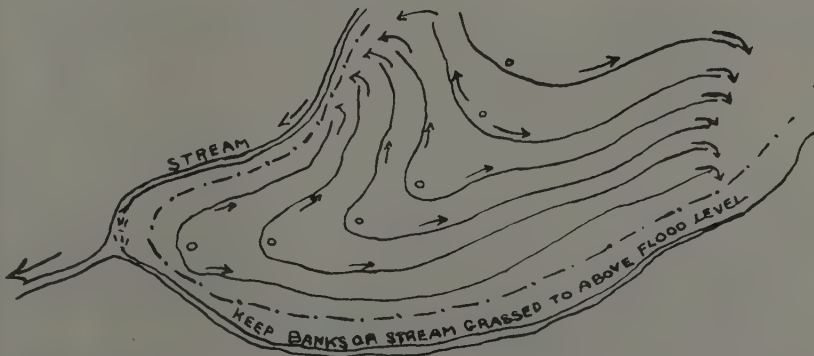
Natural outlets discharging into grass at the end of terraces where the water spreads out over the grass. Where necessary there should be a cut-off drain and bank above the field where water comes on to the field from above.



Cut-off drain and bank. Where the cut-off drain is long or carries water from a large area the discharge should be spread through several openings at intervals so that it is not concentrated. Openings must be grassed or stoned for protection, and are at the same level.



Terraces on hilltop. Terraces follow contour round the hill, falling from O both ways and discharge the run-off water into a grassed outlet, A B, for safe discharge of water. A B is sodded and seeded to grass where natural cover is not good, and must be protected, no paths being allowed; paths must cross terraces at protected points.

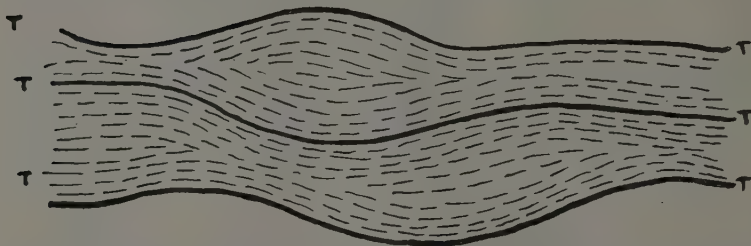


Wherever possible terraces should discharge at the ends into natural protected grassland, as in the case of the above field on a hillside between the fork of two streams. The ends of terraces must be staggered, the top extending further than the one below in each case, so that the water flows clear of the terraces below.

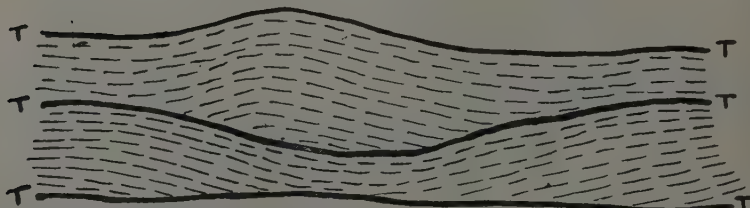
PLANTING METHODS ON TERRACED PYRETHRUM FIELDS



On easy slopes straight lines running across banks on the average direction of the contour.



On steep slopes with irregular contours, the lines are planted parallel to banks with top lines parallel to upper terrace and lower parallel to lower terrace in each case, the odd short lines coming to the centre.



On steep slopes, alternative method. All lines parallel to the upper terrace in each case with the short lines at the bottom running into the channel of the terrace below. The upper lines start on the terrace parallel to it, just clear of the channel.

grassed terrace outlets should be made to reduce the length of the terraces if necessary.

The fall of the terrace channel should be as follows:—

	<i>Fall</i>
0 to 300 feet	.. $\frac{1}{2}$ in. in 100 feet
300 to 600 feet	.. 1 in. in 100 feet
600 to 900 feet	.. 2 in. in 100 feet
900 to 1,200 feet	.. 3 in. in 100 feet

The vertical distance between terraces will depend upon the slope, as follows:—

<i>Slope.</i>	<i>Vertical Distance between Terraces.</i>
Below—	
1 foot in 100 ft.	.. 1 ft.
Above—	
1 foot in 100 ft.	.. 2 ft.
2 feet in 100 ft.	.. 2 ft. 6 in.
4 feet in 100 ft.	.. 3 ft.
6 feet in 100 ft.	.. 3 ft. 6 in.
8 feet in 100 ft.	.. 4 ft.
10 feet in 100 ft.	.. 4 ft. 6 in.
12 feet in 100 ft.	.. 5 ft.
14 feet in 100 ft.	.. 5 ft. 6 in.
16 feet in 100 ft.	.. 6 ft.
18 feet in 100 ft.	.. 6 ft. 6 in.
20 feet in 100 ft.	.. 7 ft.

If the land is eroded or deficient in humus and the soil non-absorbent, it may be desirable to reduce the vertical spacing by 10 per cent. When natural depressions are present in the field, the terraces should be started from these points, leading the water out of the hollows in order to prevent the risk of gully formation. It is not advisable to use level contour banks, since pyrethrum is very susceptible to damage by waterlogging.

The terrace banks should be constructed from the *top* side only, taking most of the soil from the channel to form the bank. The bank should be about six feet wide, the channel, which must be

excavated to have a gently curving cross section, having about the same width. The banks can be made wider than this if desired, but they should not be made narrower, since steep-sided banks require a great deal of upkeep due to removal of soil by cultivation and by erosion. The height of the *settled* bank (about 10 per cent decrease in height of the new bank must be allowed for, owing to settling) should be 12 in. to 15 in. above the bottom of the channel.

The channel, from top of the bank to the point on the same level on the slope of the land above the channel, should have a minimum cross-section of four or five square feet, rising to six square feet at the outlet end of the channel. This cross-sectional area is given by multiplying the distance in feet from the top of the bank to the point level with it on the slope above by the height of the top of the bank, in feet, above the bottom of the channel, and dividing by two.

DRAINAGE

It has been mentioned that pyrethrum is intolerant of waterlogged conditions. Not uncommonly, some of the soils at high altitudes in Kenya are rather shallow and subject to waterlogging. In such cases it will be found beneficial to deepen the terrace channel till it is as much as two feet below the ground level, although the same gentle grade must be maintained on the floor of the channel.

In order to prevent erosion in this drainage channel, dug deep into the sub-soil, it should be planted with Kikuyu grass or other suitable grass. The grass should be cut at intervals. Kikuyu grass should not be planted unless it is certain that there will always be sufficient labour available to keep it from spreading into the field; alternatively, *Paspalum dilatatum*, a non-running grass, might be used.

TERRACE OUTLETS

If there are no natural points of discharge for the terraces—into well-covered grassland or woodland—it may be necessary to make special terrace outlets. The outlets can be bounded by banks if so desired.

The terrace outlets should be planted with Kikuyu grass and the edges of the grass should be kept trimmed by slashing with *pangas*.

Slopes up to 15 per cent, well covered with Kikuyu grass, will usually withstand the wash of water in the terrace outlet without suffering erosion; but if it is wished to discharge water down a steeper grade than this it will be necessary to insert a few check dams of stone or wood to reduce the rate of flow of the water.

The size of the terrace outlet will be dependent upon the acreage which is being drained into the outlet. There are no data in Kenya Colony for the amount of run-off to be expected from catchment areas of various sizes and under various types of cover. The accompanying table has been extracted from "Terraces Outlets for Missouri". Circular 355 of the University of Missouri College of Agriculture, December, 1936. Acknowledgments are made to the author, Mr. Marion W. Clark.

MAINTENANCE

It is essential that the labourers when weeding the banks shall pull the weeds upwards or sideways. If they are allowed to dig downwards, which will be their natural tendency, the banks will rapidly be destroyed.

The pyrethrum should be planted on the contour, the rows running parallel to each bank in turn, short rows being led into the channels.

It is an advantage if the pyrethrum is planted closer in the row, with wider

spacing between the rows; for example, 15 to 18 inches apart in the rows and three feet between the rows, rather than equi-distant each way. This method of planting cheapens cleaning costs and helps protect the soil.

Boys walking to and fro from fields to drier should be made to walk in the terrace channels as far as possible, otherwise they will be liable to make tracks across the banks and to weaken them.

Pyrethrum has not been under cultivation in this Colony for a sufficient time to determine whether it should occupy a place in a definite rotation in order to keep up soil fertility. It must be borne in mind, however, that the maintenance of a sufficiently high humus content and good crumb structure in the soil is of first importance in reducing the extent to which erosion takes place.

The high prices which have been received for pyrethrum during the last year or two have caused a considerable increase in the acreage which has been put under the crop in Kenya Colony. Since pyrethrum thrives at high altitudes, a great deal of the land upon which it is grown is rolling or steeply rolling, while the nature of the soil, often rather poorly drained, renders it very subject to erosion when cultivated.

Many of the earlier pioneers of the pyrethrum growing industry became convinced several years ago of the necessity to prevent erosion in their pyrethrum. It is important that new pyrethrum growers should realize and appreciate the danger of loss of crop, soil, and land which may be caused by soil wash.

Lack of foresight in preparing land for pyrethrum growing is hardly excusable with the amount of experience which is now available. If pyrethrum prices remain high then the fertility of good

pyrethrum land must be retained in order to harvest remunerative crops; if the price slumps in a year or so, the wise grower will be thankful that he does not have an unfortunate memento of his pyrethrum-growing days in an area of ruined land, an eyesore to the farmer, which will grow neither crops nor good grass but which is a danger to the surrounding land through being a focus for erosion.

Finally, there are two points which must be mentioned with reference to soil conservation on the farm as affected by pyrethrum growing; they are the provision of fuel and the control of "squatters".

Only too often farmers cut down ruthlessly the scanty indigenous timber which remains on the farm, trees which may be protecting stream banks or catchment areas, in order to provide fuel for the pyrethrum driers.

Every farmer who contemplates growing pyrethrum should, as a matter of course, immediately plant sufficiently extensive plantations of quick-growing gums to provide him with all the fuel he is likely to need.

The following average data may be used in calculating the provision of fuel which should be made for drying pyrethrum flowers:—

- (1) Working at a temperature not exceeding 130° F., 4 lb. of fuel will be required to produce 1 lb. of dry flowers.
- (2) One acre of gums at ten years old will yield, on the average, 4,000 cubic feet of fuel, or 1,500 cubic feet at five years old.
- (3) One ton of fuel = 60 cubic feet.

Therefore ten acres of pyrethrum, yielding about 600 lb. of dry flowers per acre per year, will need annually about 660

cubic feet, or about one-sixth of an acre of gums ten years old, or half an acre of gums cut at five years.

Similarly, ten acres giving 1,000 lb. of dry flowers per acre will need 1,080 cubic feet, or a quarter of an acre of gum trees cut at ten years old, or two-thirds of an acre cut at five years.

Secondly, since an ample supply of labour is an essential in pyrethrum-growing, the farmer may welcome on to his land numbers of squatters.

They cut down and burn timber, bring large numbers of sheep and goats on to the farm, and cultivate sheer slopes which erode rapidly.

Woodland on steep slopes and in catchment areas should be protected from the destructive activities of squatters. Goats should be forbidden, and the numbers of sheep per family strictly limited, while the grazing should be controlled, over-grazed areas being given a resting period for recovery.

The "squatter" *shambas* must be protected by terrace banks in the same way that the pyrethrum fields of the farmer are protected. The European community cannot afford to have large areas of land in the Highlands ruined by the casual method of shifting cultivation.

The farmer who expects to make a profitable living out of pyrethrum should be ready to spend a little time in setting out contour lines on the land given up for the cultivation of his resident labourers and to ensure that efficient construction and subsequent maintenance of the banks is carried out by the labourers and their families.

Contour banks can be assisted to control erosion by strip-cropping and by placing lines of rubbish on the contour in between the banks.

TABLE—TO BE USED FOR THE DESIGN OF GRASSED OUTLETS

Velocity Approximately 3.5 ft. per Second (Outlet Width to Nearest Whole Foot). Depth of Flow Given in Inches. Side Slopes of Outlet $1\frac{1}{2}$ to 1

Percentage Slope in Outlet	Acres																38	42	46	50
	2	4	6	8	10	12	14	16	18	20	22	24	26	30	34	38				
1* Width of outlet..	3'	4'	5'	5'	5'	6'	7'	6'	7'	8'	8'	9'	9'	6'	7'	8'	9'	10'	12'	12'
† Depth of flow ..	12"	15"	15"	18"	21"	21"	21"	24"	24"	24"	24"	24"	24"	30"	30"	30"	30"	30"	30"	30"
1 Width of outlet..	1'	1'	2'	1'	2'	2'	3'	3'	4'	4'	5'	5'	5'	7'	8'	9'	10'	12'	14'	14'
2 Width of outlet ..	10†	12†	12†	15"	15"	15"	15"	15"	15"	15"	15"	15"	15"	15"	15"	15"	15"	15"	14"	14"
2 Depth of flow ..	1'	2'	4'	5'	7'	8'	8'	8'	8'	8'	8'	8'	8'	17"	20"	22"	25"	28"	31"	31"
3 Width of outlet..	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"
3 Depth of flow ..	2'	4'	7'	8'	11'	13'	15'	16'	18'	20'	22'	23'	24'	28"	29"	34"	37"	42"	45"	45"
4 Width of outlet..	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"
4 Depth of flow ..	4'	6'	10'	12'	17"	20"	22"	24"	27"	29"	31"	33"	35"	40"	43"	46"	54"	62"	68"	68"
5 Width of outlet..	5"	5"	5"	5"	5"	4 $\frac{3}{4}$ "	4 $\frac{3}{4}$ "	4 $\frac{3}{4}$ "	4 $\frac{3}{4}$ "	4 $\frac{3}{4}$ "	4 $\frac{3}{4}$ "	4 $\frac{3}{4}$ "	4 $\frac{3}{4}$ "	4 $\frac{3}{4}$ "	4 $\frac{3}{4}$ "	4 $\frac{3}{4}$ "	4 $\frac{3}{4}$ "	4 $\frac{3}{4}$ "	4 $\frac{3}{4}$ "	4 $\frac{3}{4}$ "
5 Depth of flow ..	5'	9'	13'	18"	23"	26"	30"	33"	37"	40"	42"	45"	48"	54"	58"	61"	69"	—	—	—
6 Width of outlet..	4"	4"	4"	4"	4"	4"	4"	4"	4"	4"	4"	4"	4"	4"	4"	4"	4"	4"	4"	4"
6 Depth of flow ..	7'	12'	19'	25'	31'	37'	43'	46'	49'	54'	59'	62'	65'	73"	—	—	—	—	—	—
7 Width of outlet..	3 $\frac{1}{2}$ "	3 $\frac{1}{2}$ "	3 $\frac{1}{2}$ "	3 $\frac{1}{2}$ "	3 $\frac{1}{2}$ "	3 $\frac{1}{2}$ "	3 $\frac{1}{2}$ "	3 $\frac{1}{2}$ "	3 $\frac{1}{2}$ "	3 $\frac{1}{2}$ "	3 $\frac{1}{2}$ "	3 $\frac{1}{2}$ "	3 $\frac{1}{2}$ "	3 $\frac{1}{2}$ "	3 $\frac{1}{2}$ "	—	—	—	—	—
7 Depth of flow ..	8'	17'	27'	33'	42'	48'	56'	62'	67'	75'	—	—	—	—	—	—	—	—	—	—
8 Width of outlet..	2 $\frac{3}{4}$ "	2 $\frac{3}{4}$ "	2 $\frac{3}{4}$ "	2 $\frac{3}{4}$ "	2 $\frac{3}{4}$ "	2 $\frac{3}{4}$ "	2 $\frac{3}{4}$ "	2 $\frac{3}{4}$ "	2 $\frac{3}{4}$ "	2 $\frac{3}{4}$ "	—	—	—	—	—	—	—	—	—	—
8 Depth of flow ..	2 $\frac{3}{4}$ "	2 $\frac{3}{4}$ "	2 $\frac{3}{4}$ "	2 $\frac{3}{4}$ "	2 $\frac{3}{4}$ "	2 $\frac{3}{4}$ "	2 $\frac{3}{4}$ "	2 $\frac{3}{4}$ "	2 $\frac{3}{4}$ "	2 $\frac{3}{4}$ "	—	—	—	—	—	—	—	—	—	—
10 Width of outlet..	2 $\frac{1}{2}$ "	2 $\frac{1}{2}$ "	2 $\frac{1}{2}$ "	2 $\frac{1}{2}$ "	2 $\frac{1}{2}$ "	2 $\frac{1}{2}$ "	2 $\frac{1}{2}$ "	2 $\frac{1}{2}$ "	2 $\frac{1}{2}$ "	2 $\frac{1}{2}$ "	—	—	—	—	—	—	—	—	—	—
10 Depth of flow ..	13'	27'	35'	44'	54'	62'	73"	—	—	—	—	—	—	—	—	—	—	—	—	—
12 Width of outlet..	2"	2"	2"	2"	2"	2"	2"	2"	2"	2"	—	—	—	—	—	—	—	—	—	—
12 Depth of flow ..	15'	33'	47'	60'	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14 Width of outlet..	1 $\frac{3}{4}$ "	1 $\frac{3}{4}$ "	1 $\frac{3}{4}$ "	1 $\frac{3}{4}$ "	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14 Depth of flow ..	20'	39'	57'	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16 Width of outlet..	1 $\frac{1}{2}$ "	1 $\frac{1}{2}$ "	1 $\frac{1}{2}$ "	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16 Depth of flow ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

*This line is for use in design of outlets for mechanical control. Average length of notch in structure is to be same as bottom width of outlet. Notch depth to equal or slightly exceed depth of flow. Velocity between structures 3.5 ft. sec. and under.

† Denotes designs in which velocity has been lowered to keep bottom width of outlet 1 ft. or over.

NOTES ON ANIMAL DISEASES

Compiled by the Department of Veterinary Services, Kenya Colony

IV—RINDERPEST

Rinderpest is an acute contagious virus disease of ruminants and swine, characterized by diarrhoea, nasal and lachrymal discharge and by ulceration of the mucous membrane of the mouth.

Etiology.—Rinderpest is caused by an ultravisible and filtrable virus which becomes attached to the white cells of the blood and blood-forming organs.

Symptoms. — After an incubation period of from two to nine days the temperature rises sharply to 104° F. or more. The muzzle appears dry and the coat staring. The appetite is reduced, and after one or two days a little discharge is noticed at the eyes and nose. The eye becomes very susceptible to light and the mouth very congested. The temperature remains elevated for three days to a week, after which it falls to normal or below normal. At this time coughing may be noticed, diarrhoea is always present, and an examination of the mouth will show pitted elevations of the lower gum, the dental pad, the inner aspect of the angles of the mouth, and the sides and lower surface of the tongue. By this time the animal has usually lost condition, the eyes are sunken and the flanks hollow. Grinding of the teeth and other symptoms of abdominal pain are evident, and diarrhoea becomes more and more marked. Dysentery is frequently observed, and the animal becomes very weak and unable to rise. Death usually occurs ten to twenty days after infection. Breakdowns to red-water and less frequently to coccidiosis may occur, and pregnant animals that recover from the disease usually abort during the third week after infection.

Post-mortem Lesions.—In natural cases of the disease in adult animals the post-mortem lesions are usually characteristic. The mouth, pharynx, larynx, and, in the female, the vagina are markedly inflamed and show patches upon which the epithelium has become lost or changed into a cheesy deposit. Although considerable areas may be raw, examination of adjacent areas less severely affected shows that the lesions begin as numerous pin-head-sized ulcers. Larger areas are formed by the confluence of numbers of such ulcers.

The fourth stomach is usually intensely inflamed and several shallow irregular-shaped ulcers with hæmorrhagic margins are almost constantly present. On the folds in the anterior portion the ulcers are usually very narrow and elongated. Nearer the junction with the intestines (the pylorus) the ulcers are more round or oval in shape, and traces of yellowish-grey necrotic mucous membrane may still be adhering. Diffuse congestion and sometimes free hæmorrhage is present in the small intestine. In the large intestine the cæcum shows typically a network of broad bands of congestion and longitudinal lines of hæmorrhages are constantly seen in the rectum. Diffuse patches of congestion and hæmorrhage may be present throughout the large intestine.

The liver and spleen are usually somewhat swollen and engorged with blood. The kidneys are congested, particularly the medullary (inner) portion of the pyramids. The mucous membrane of the bladder often shows small hæmorrhages, and of course when a breakdown to red-water has occurred the urine is deep red in colour.

Usually the lungs show emphysema—distension of lobules and septa with air—so that small bubbles are seen on the surface. Some congestion or secondary pneumonia may also be present. The heart shows small black hæmorrhages under the membranes lining both the outside of this organ and the inside of the cavities.

The typical mouth lesions of rinderpest occur in one other disease of cattle only—malignant catarrh. In Kenya diarrhoea and intestinal lesions are rarely seen in the latter disease, while the very marked increase in size in the lymphatic glands in malignant catarrh makes differential diagnosis easy. Isolated cases of rinderpest in calves or in partially immune animals may be somewhat atypical in that the characteristic mouth lesions may be lacking. Usually, however, rinderpest is one of the easiest diseases to recognize.

Animals Susceptible.—All ruminants and pigs are susceptible to rinderpest, but the degree of susceptibility varies. Among domesticated animals, cattle and buffalo are highly susceptible, mortality in uncontrolled outbreaks of the disease often surpassing 90 per cent. In India and East Africa, sheep and goats are relatively resistant to strains occurring naturally. Although these animals may be infected by the inoculation of virulent material, apart from a temperature reaction they show little evidence of infection. In French West Africa, however, a large breed of goats occurs which reacts severely to inoculation. Pigs on infection behave similarly to sheep and goats. Camels are slightly more susceptible. Among wild species, buffalo, eland, kudu, and wart-hog appear to be the most susceptible. Mortality in these species is heavy, and they are of great importance in spreading the disease from farm to farm and from district to district. Giraffe,

bush-buck and forest-hog are only slightly less susceptible, but although other species of buck may contract the disease mortality in them is unusual.

Although herds of buffalo and other game are of great importance in the spread of rinderpest in East Africa, it is the considered opinion of those who have studied the question that game do not harbour rinderpest for long periods. Rinderpest spreads rapidly in buffalo herds, so that after a comparatively short time all the susceptible animals have either died or recovered to become immune.

Transmission.—Rinderpest is a contagious disease. The virus is present in all the discharges of sick animals, and healthy cattle contract infection through eating or drinking contaminated material. The virus is a relatively delicate virus, being rapidly destroyed outside the animal body by physical and chemical agents. Blood at room temperature loses its infectivity in a few days when kept under the most favourable conditions, and materials splashed with blood become harmless in three days even when stored near freezing point.

The virus does not resist the action of O.C.G. preservative, and for confirmation of diagnosis blood should be collected in sterile citrate solution and despatched to the Laboratory with as little delay as possible.

Treatment.—There is no specific drug of value in the treatment of rinderpest. Hyperimmune serum in doses of 250 to 500 c.c. may be used for cattle that have been exposed to infection, but it is very doubtful if the inoculation of hyperimmune serum can modify the course of the disease when it is given after symptoms other than a rise in temperature have appeared.

Bleeding a few hundred cubic centimetres from the jugular vein appears to be beneficial when the temperature is high.

Preventive Inoculation.—Rinderpest is usually combated by prophylactic inoculations. Several methods are available, each of which has its uses.

The oldest method in use to-day is the "serum alone" method. Serum alone gives immunity for two to three weeks only, but protection is afforded as soon as the serum is injected. Serum alone is only employed therefore in an emergency. For cattle of average susceptibility the dose is 15 c.c. per 220 lb. live weight, but for more susceptible animals the dose should be increased to 20 c.c. per 220 lb. or more.

For the protection of dairy cattle and in areas where the introduction of live virus is undesirable, vaccine is employed. A course of vaccine will usually confer protection for from one to four years. Highly susceptible cattle appear to gain a more durable immunity than cattle of low susceptibility, and the response to vaccine is better in fully adult animals than in yearlings.

It has been found that once an animal has received a full course of three doses, immunity may be reinforced by a single annual inoculation of vaccine. When using vaccine therefore the recommended procedure is to give every animal a full course of three inoculations of 10 c.c. at weekly intervals once it is over twelve months old. In subsequent years the animals previously treated with a full course receive a single 10 c.c. dose, whilst the yearlings that have come on since the last inoculation receive a full course of three doses.

When calves are inoculated by any of the methods in use to-day a proportion,

which may exceed 50 per cent, fails to develop a durable immunity. Calves may be given a single dose of vaccine when rinderpest is in the vicinity of the farm, but otherwise can be left untreated.

The other methods of immunization necessitate the use of live virus, which in Kenya may only be employed by the staff of the Veterinary Department. These methods differ from those already described in that in adult cattle they confer a life-long immunity.

The first of these methods to be developed was the double inoculation method, which was first introduced into Kenya by Montgomery in 1910. In this method, serum is inoculated on one side of the animal and virus on the other. The severity of the reaction is controlled by the serum, and the animal develops a mild attack of the disease, as a result of which adults acquire a life-long immunity. In calves, however, the resultant immunity may not be permanent.

The disadvantages of the method arise from the difficulty in accurately balancing the dose of serum and from the fact that, if reactions are severe, infection may spread into game. Severe reactions may occur in animals in poor condition or in animals exposed to bad climatic conditions. Animals premunized to redwater and anaplasmosis may relapse and pregnant female stock often abort. The mortality as a rule does not exceed 2 per cent.

Shortly after the introduction of inactivated vaccine in Kenya, the possibility of converting the temporary vaccine immunity into a more permanent form was explored, and the vaccine-virus method was eventually elaborated. A single dose of 15 c.c. of vaccine is given, and this is followed thirteen to fifteen days later by

a large dose of spleen virus. The resulting reaction is usually milder than that following double inoculation and in some cases is imperceptible. The immunity produced appears to depend on whether a satisfactory reaction is induced by the virus. When a good reaction occurs, the immunity is probably as durable as that following double inoculation, but a variable percentage of animals may not react and they become susceptible again when the vaccine immunity has waned.

In view of the difficulty and expense involved in preparing large quantities of serum and vaccine, search for a cheap, efficient immunizing agent has been in progress for many years. The only hope of eradicating rinderpest from territories like the East African territories, populated as they are largely by backward peoples owning herds of low-valued cattle, lies in the wholesale immunization of stock with a cheap product conferring a durable immunity.

Experiments conducted by Edwards in India showed that when rinderpest virus was passed many times through goats its virulence for cattle decreased. As a result of these experiments, goat virus was introduced in India for the field immunization of the relatively resistant plains cattle. This virus was imported into Kenya in 1937, but was found to be too virulent for use on local cattle. Passaging of the stock Kabete virus had been started in 1936. No evidence of attenuation was noticed until the 85th passage, since when the virus has become progressively less virulent, and early this year

(1939), after 270 passages, it proved suitable for use as a field immunizing agent provided that the cattle were in good condition, that grazing was good and that there was no exposure to inclement weather during the reaction period.

Like all methods conferring an active immunity, goat virus must produce a reaction to achieve a result. As in double inoculation, therefore, a small mortality is almost unavoidable. There is reason to believe, however, that by continued passage the Kabete and other strains of virus which are also being investigated will become further attenuated, so that mortality will be negligible even when conditions are not ideal. A most important feature of this method of immunization is the fact that the mild disease induced by inoculation does not appear to be contagious either to cattle or goats, and there is thus less danger of the creation of foci of infection from immunizing inoculations. A technique has also been evolved for desiccation of the virus which allows it to be preserved for several weeks without loss of potency and to be transported in concentrated form. Material for several hundred inoculations can thus be carried in a phial that need not be larger than an ordinary fountain-pen. Already, in several reserves, goat virus has been introduced in Kenya as a field service to replace the double inoculation method. The reception that it has been accorded by the African augurs well for the eradication of rinderpest—undoubtedly the most serious disease of cattle and the greatest obstacle to the proper development of animal husbandry in tropical Africa.

OBSERVATIONS ON THE LIFE-HISTORY AND CONTROL OF WHITE BORER OF COFFEE IN KENYA

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INTRODUCTION

In Kenya few of the wood-boring beetles are of economic importance, because their indigenous hosts have no commercial value and so do not come under the observation of man. An important exception is the Cerambycid beetle, *Anthores leuconotus* Pasc., which is a major pest in certain of the coffee-growing districts.

The adult white borer is a large elongate beetle, the female measuring approximately 30 mm. long and 10 mm. wide, the male approximately 27 mm. by 8 mm.; occasional individuals may be considerably smaller. As the coloration of the two sexes is similar the only external difference readily observable is the length of the antennæ, which in the male are twice the length of the body, while in the female they are only slightly longer than the body. The head and thorax are dark brown in colour, somewhat speckled with yellowish-brown, while the elytra are a dull, dirty white, brown at the base and having in the middle a band of deep brown, broader at the lateral margin.

According to James [1] the white borer occurs in Natal, Northern Transvaal, Portuguese East Africa, Nyasaland, Zanzibar, Tanganyika, Uganda, Belgian Congo, the Cameroons, and Kenya. The first recorded occurrence of the insect in this country was in 1909. In 1914 it was reported in coffee of the Bura Mission, near Voi, but from then until 1927 nothing more was heard of it. In 1927 it was found to be doing considerable damage to coffee in the Ithanga Valley, between 4,500 and 5,000 feet. Since that

date it has done much damage on the lower estates, and has been found up to 5,300 feet, though serious outbreaks have not been recorded as high as this.

All states of the coffee bush are not suitable for the development of the borer. Good trees with really sappy wood are seldom attacked, and on the other hand neither have very poor, nearly dead trees been found to be attacked. Trees in an intermediate condition, those showing marked debility, are chosen, and so the patches of coffee most severely attacked by borer are those growing on poor, eroded, or otherwise impoverished soils. From this it follows that the borer is a more severe pest at the lower elevations in the Ithangas and less severe on the higher plantations where the soils are noticeably richer and deeper. All those cultural practices which improve the soil will thus have a beneficial effect on the borer position. It should be mentioned here that in parts of Tanganyika the borer has been found to favour shade, situations near to water, and coffee in good condition. This difference has not apparently been explained.

OBSERVATIONS ON THE LIFE-HISTORY

A—The Egg

The egg, which is white or a very light cream in colour, is approximately $5\frac{1}{2}$ mm. long and 2 mm. wide. It is more pointed at one end than at the other and is laid in a perpendicular position with the pointed end uppermost, between the bark and the wood of the tree. It is inserted under the bark by the extended ovipositor.

The only external sign of the presence of an egg is a small depression in the bark of an irregular shape and of approximately 1 mm. wide and $1\frac{1}{2}$ to 2 mm. long, usually made horizontally, in which may be seen a dark brown, shiny substance. When fresh, this substance is a quick-drying, sticky fluid which is discharged by the female after oviposition and is used both to keep the egg in position and to seal the cavity in which the egg was placed.

Above this depression may be seen a slight bulge of the bark, which often shows a perpendicular crack across the bulge. This is caused by the forcing up of the bark to make room for the egg, the lowest portion of which is about $1\frac{1}{2}$ mm. above the depression. Occasionally a portion of the egg may be seen protruding from the bark, but this is a rare occurrence, probably indicating that the place selected by the female was unsuitable.

Usually, but not invariably, the larger trees with a rough bark are selected as the site for egg-laying, rather than those with small boles and smooth bark, but larvæ have quite frequently been seen on trees whose stems were only an inch in diameter.

At 4,200 feet, the incubation period of the egg was determined to be between 20 and 23 days, while at 5,300 feet it was known to be considerably longer. It is possible also that dry conditions may lengthen the incubation period, as eggs laid on short lengths of coffee stem that afterwards dried out considerably took between 25 and 30 days to hatch.

B—The Larva

When it hatches, by biting a way through the lower end of the egg, the larva is a small, nearly cylindrical, legless grub, about 3 mm. long and $1\frac{1}{2}$ mm. wide.

It is dirty white in colour, and has a pair of powerful brown mandibles, which are subsequently used for boring into the hard wood of the tree.

Immediately after hatching, the young larva commences to tunnel under the bark, and the excreta at this stage are in the form of minute particles of sawdust. During the first ten days the larva grows rapidly and becomes flatter in form and the body segments become more clearly defined. It still makes very slow progress under the bark, but it now produces long strands of woody material, which are so characteristic of the larva of *Anthores*, although at this stage they are very slender and soft.

No external signs can at first be seen of the larva, but as it grows and tunnels the strands of wood must be ejected from the burrow, and about thirty days after hatching minute particles of wood may be seen protruding from the incision in the bark through which the egg was laid. At this stage the larva has progressed only about an inch from where it hatched but within the next three weeks it attains a length of 13 to 14 mm. and may have moved a distance of four inches. For the next two to two and a half months, until it enters the wood of the tree, the larva may average a distance of $\frac{1}{4}$ in. per day.

During the bark-boring stage the larva usually descends spirally towards the roots of the tree, whether the egg was laid at ground level or high up on the stem, though some larvæ work upwards for a short period. The bark-boring appears to be only a transitory stage during which the larva is gaining sufficient strength to penetrate the hard wood of the tree, and instances have been seen where larvæ of only three weeks old have commenced to bore into a soft spot in the wood, but on reaching harder wood have been forced

to return to the bark. At the base of the stem, where the wood is hard, a larva may travel a distance of 18 to 20 inches before entering the wood, and usually this entry takes place under a primary root where this joins the main stem. Higher up the stem, where the wood is softer, it is unusual to find that a larva has travelled more than once round the stem, or about three to five inches in distance.

Under natural conditions the larva is between three and four months old when it starts to bore into the tree. For the next twenty months or so it makes steady though slow progress in the tree, boring always upwards and never altering direction.

During the moults, the exact number of which has not been determined, the larva is comparatively inactive. At the time of entering the wood the larva is approximately one inch long and by the time it is ready to pupate it is approximately three inches long and half an inch in diameter. At this stage it is creamy white in colour and very distinctly segmented.

The larva makes an undetermined number of trips to the outer bark, which it eats. Larvæ have been found outside the tree between the bark and the surrounding earth a full two inches from their borings, to which they presumably return.

As the time of pupation approaches the larva excavates a broad hollow at the upper end of the larval passage. This pupal chamber is so made that only a thin film of wood remains under the bark at the upper end, the adult thus having only a minimum of work to do to liberate itself after emergence. While the pupal chamber is being excavated the shavings removed are packed in the larval passage from the entrance to the chamber. These shavings differ from those made by younger larvæ in that the strands are

much coarser and are packed much more tightly. It is possible after some practice to tell at a glance whether the insect in any given tree is still a larva or whether it is in the pupal or pre-pupal stage by the look of these shavings.

C—The Pupa

The pupa of *Anthores* is approximately 32 mm. long and 14 mm. wide. It is soft-skinned and white in colour, but gradually grows darker as the time approaches for the adult to emerge. The pupal period is stated by James [1] to be between 38 and 42 days. Many larvæ have been seen excavating pupal chambers in November-December, and these would normally emerge as adults during the March-April rains.

D—The Adult

When the adult emerges from the pupal skin it is still very soft and white. Another two or three weeks elapse before the beetle attempts to liberate itself, and during this period the body hardens and



Male.

Female.

(Actual size)

darkens in colour. Liberation is effected by biting out a circular hole approximately 10 mm. in diameter in the thin upper end of the pupal chamber. The emergence occurs during rainy weather and begins, roughly, a week after the first heavy fall of rain.

Some idea of the distribution of emergence is obtained from Table I, which shows the numbers of adults captured on an estate in the Makuyu district during the two rainy seasons from 1935 to 1938.

TABLE I

YEAR	March-April-May Rains	November-December Rains
1935	846	401
1936	1,242	*220
1937	5,336	649
1938	816	—

*Rainfall below average.

The weekly rainfall and captures of adult beetles on one estate during the long rains of 1937 are shown in Table II.

TABLE II

WEEK ENDING	Rainfall in Inches	Beetles Collected
3rd April ..	2.60	—
10th April ..	2.55	902
17th April ..	3.12	1,772
24th April ..	2.03	1,026
1st May ..	0.81	440
8th May ..	0.00	225
15th May ..	1.40	21
22nd May ..	1.85	20

At the beginning of each peak of emergence during the rains male beetles predominate, while later the females appear in a larger proportion, as shown in Table III.

TABLE III

DATE, 1937	Males	Females
14-15th April ..	963	308
27-28th April ..	68	113
5th May ..	28	52
26th May ..	31	117
11th November ..	111	64
24th November ..	105	106

The adult does not fly readily; if touched when on a tree it usually drops to the ground and remains motionless. Beetles are more active in bright sunlight than on cloudy days, and on very wet, cold days they may remain in the same place all day. The food of the adult consists of the bark of coffee branches or shoots and the skin of green coffee cherries. The beetle also bites off young shoots and leaf-stalks, but this form of damage is trifling.

The female usually lays one or two eggs in twenty-four hours; if only one, it is laid usually at night; if two, one is laid at night, the other during the day. The actual time taken in ovipositing, excluding that required for biting out the bark, is between five and eight minutes.

Table IV records the oviposition of one female which emerged on the 10th November, 1937. A male was present in the cage throughout.

TABLE IV

Date 1937	No. of Eggs	Date 1937	No. of Eggs	Date 1937	No. of Eggs	Date 1937	No. of Eggs
Nov. 12	1	Nov. 21	1	Nov. 30	2	Dec. 8	1
13	1	22	1	Dec. 1		9	2
14	1	23	1	2	2	10	0
15	1	24	2	2	2	11	0
16	2	25	2	3	2	12	0
17	0	26	2	4	0	13	2
18	1	27	2	5	2	14	0
19	1	28	0	6	1	15	1
20	1	29	2	7	1		
Total							40

The female was dissected on the 16th December and found to contain six mature eggs. Two other females observed laid 23 and 11 eggs in 24 and 27 days respectively. A further ten females were released in a cage made of *americani* (coarse calico), measuring 6 ft. x 5 ft. x

5 ft., in which was growing a mature coffee tree, and laid a total of 40 eggs in four days.

The male moves rapidly in search of a female and mounts her as soon as he finds her. The female does not interrupt her feeding or appear to take any interest at this time. Copulation may take as long as one and a half hours to complete. Males fight readily and fiercely for possession of a virgin female. Adults do not appear to be strongly attracted to bright light at night. Emergence always occurred at night in cases under observation.

INDIGENOUS HOST TREES

In addition to coffee, the white borer attacks a number of indigenous host trees, all belonging to the Rubiaceae. Davies [2] gives a list of hosts in Tanganyika. Little is known of the wild hosts in Kenya, two only having been definitely determined, *Gardenia urcelliformis* Schweinf ex Hiern. and an unidentified tree (*Mutungiri, Mkoo*). In addition, *Vangueria linearisepala* K. Schum. (*Mubiru, Kikuyu*) and a species of *Canthium* are suspected hosts, and doubtless a number of the other Rubiaceous shrubs and trees which grow in the borer area may be attacked. It is interesting to note that nearly all the native host trees which contained borer larvæ were growing close to dry rocky outcrops, well away from water. Larvæ were very seldom found in trees growing near streams.

NATURAL ENEMIES

The first recorded enemy of *Anthores* was observed by the writer in April, 1937, when it was seen that a species of woodpecker was feeding on borer larvæ in an indigenous host tree (*Gardenia urcelliformis*). The bird pecks a hole through the wood straight into the larval passage and then devours the larva. In one area where there were a considerable number

of bored trees, nearly 25 per cent of the larval passages were seen to have been attacked in this manner. This must have an appreciable influence on the borer population in wild hosts.

Another enemy is the Braconid *Iphiaulax varipalpis* Cam. This was first observed by the writer in August, 1937. The ovipositor of the parasite is inserted through the bark and the egg laid in the larval boring. When it hatches, the small parasite larva worms its way along the passage until it reaches the host, to which it attaches itself, and it remains ectoparasitic throughout life. By the time the parasite is ready to pupate the borer larva is nothing but a dry skin. The parasite pupates in a silken cocoon in the larval passage. On emergence from the cocoon the adult parasite bites a circular hole through the bark and escapes. The borer larvæ are liable to attack by the parasite up to the time when they enter the wood of the tree, but no signs have been seen of those inside the tree being attacked.

The parasites are often to be seen flying in and near borer-infested estates. In order to obtain data on the parasitism of white borer by this insect, two hundred new larval borings were examined on each of three estates. The results are given in Table V.

TABLE V

	Estate		
	A	B	C
Borings with—			
Living host larvæ ..	40	147	137
Living parasite larvæ or pupæ	85	27	28
No living stages of host or parasite ..	75	26	35

On estate A, because little effective control work had been carried out for several years, the population of borer was greater than on the other two estates.

CONTROL

It has already been shown that in Kenya borer attack nearly always occurs in areas of coffee in poor condition, and is seldom serious in coffee growing well in soil of good heart. The likelihood of borer attack may therefore be minimized by those cultural practices which tend to improve the condition of the soil.

A number of direct control methods have been tried. It was thought that it might be possible to treat the coffee stem with a paint or spray that would deter the female from ovipositing. For such a purpose a caustic soda and lime mixture has been used against coffee borers in India.

Experiments were made with a tar-distillate emulsion known as "Winter Spray"; a solution made up of $1\frac{1}{4}$ lb. caustic soda, 5 lb. burnt lime, and six gallons of water; and the proprietary ovicide, "Tropical Mortegg". A double coat of each liquid was applied with a paint brush to the stem of a caged coffee tree, from ground-level to a height of one foot. Beetles were released in the cages, and it was found that they laid as many eggs on the treated portion of stem as on the same portion on untreated trees. All the eggs hatched normally. The substances tried were therefore useless, and it is not thought likely that there is any substance which would destroy the egg without damaging the tree. Control measures aiming at the destruction of the larval population are, however, not only possible but of great value.

DESTRUCTION OF LARVÆ IN BARK-BORING STAGE

The larva is particularly vulnerable when it is boring in the bark and before it enters the tree. At this stage the bark should be rubbed vigorously with any rough material, such as sacking or shelled maize cobs; the outer bark will be re-

moved and larval passage revealed. By following up the passages the larva can be located and destroyed. These control measures should be undertaken as far as possible about three to four months after the eggs have been laid. At any earlier date the very small larvæ will be difficult to locate; later, the larvæ will have entered the trees and it will not be possible to locate them by this means. Since the majority of the eggs are laid at ground level it should only be necessary so to treat the lower 9 to 12 inches of the stem. This control measure should be carried out in August or September and March or April, to obtain larvæ hatched from eggs laid by females which emerged during the "long rains" and "short rains" respectively.

DESTRUCTION OF LARVÆ IN WOOD-BORING STAGE

Once the larvæ have bored into the wood, at which stage they are below ground level, the method employed is to remove the soil from around the roots near the stem, making an inverted cone-shaped depression about nine inches deep or to such a depth as will uncover the junctions of the main lateral roots with the stem. These excavations are left open for at least three days, after which larvæ in the trees will have thrown out wood chips from the boring, by which their presence is revealed. An inspection gang armed with lengths of No. 16 gauge wire, which have been curved to make sharp hooks, enters the field and examines every tree. When chips are seen they are removed from the hole and the larva is extracted with the hooked wire. With patience all the larvæ in the wood may be extracted and there is no reason why they should not all be extracted at the first inspection. In an old infested estate, however, more than one inspection will be necessary, because insects in the pupal or pre-pupal stage will not be seen.

As soon as these control measures have been completed the excavation should be filled in, so that egg-laying will not take place below ground level, as a larva hatching from such eggs would descend to a level at which it could not be located.

DESTRUCTION OF ADULT BEETLES

Hand collection of the adult beetles is considered to be of great value. A gang of children should be employed for this purpose at the beginning of each rains; a large number of beetles may thus be destroyed before they have laid many eggs. On one estate nearly 6,000 beetles were caught in one season, and this must have caused a very marked diminution of larval infestation. Cash incentives to thorough work in collecting larvæ and adult beetles are offered by many planters and it is considered that such money is usefully spent. One cent for each larva collected from coffee, and a few cents for each adult, may so increase the collection as to result in fewer inspections being necessary. One planter offers a prize of Sh. 5 for the native capturing the greatest number of larvæ during the year and Sh. 2/50 for the runner-up. The competition towards the end of the year is frantic.

Allowing for two thorough inspections, the cost of the control by making excavations and extracting larvæ may be taken to be approximately Sh. 6 per acre per annum, this figure varying according to the severity of the infestation and the cost of labour and food. This figure compares with the actual costs given by Davies [2] as between Sh. 7/39 and Sh. 4/60.

If thorough inspections, as described, were made throughout the borer area for a year or two, there is no reason why the white borer should not become for a long time a pest of only minor importance.

ACKNOWLEDGMENTS

Special thanks are accorded to Mr. T. Rundgren, Mr. T. G. Clayton and Mr. J. C. Molony for their assistance during the work and for permission to use some of their data.

Thanks are also due to Dr. R. H. Le Pelley for assistance in compiling the manuscript.

SUMMARY

Anthores leuconotus Pasc., the white borer, a beetle which in the larval stage bores in the stems of coffee, is a serious pest in the coffee-growing districts of Makuyu and Ithanga in Kenya. It there attacks chiefly debilitated coffee trees, and infestations usually begin and increase severely in coffee on eroded or otherwise impoverished soils.

Observations on the life-history of the insect are described, together with notes on a hitherto unrecorded hymenopterous parasite attacking the larvæ.

Methods of control are described, the most important being the extraction of larvæ from the tree both in the bark-boring and wood-boring stages, and also the hand-collection of adult beetles.

REFERENCES

- [1] James, H. C. (1928).—"Progress Report on Insect Pests," Dept. of Agric., Kenya, Bull. No. 22.
- [2] Davies, R. M. (1937).—"The Control of White Stem Borer of Coffee," *E. Afr. Agric. J.*, Vol. II, No. 4, January.

A SUSPECTED MINERAL DEFICIENCY AMONGST CATTLE IN UGANDA

By R. N. T.-W.-Fiennes, B.A., M.R.C.V.S., Veterinary Research Laboratory,
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Lake Salisbury, in the eastern part of the Teso district of Uganda, owes its formation, with that of Lake Gedge, to the rain falling on the western slopes of Mounts Elgon, Debasien and Moroto, and of the intervening hills Akisim, Kamalinga and others. Eastern Teso provides the catchment for a vast area of land besides these mountains and hills, in which is included the whole of South-West Karamoja. Anyone who studies a map of this region is led to the belief that South-West Karamoja is drained into the Aswa River and so directly into the Victoria Nile, but the maps are erroneous. Where the River Loliakat is shown as joining the River Aswa, in reality a swamp exists, and this swamp is drained by way of the Komolo Swamp into Lake Salisbury. The River Aswa is separated from this swamp by a ridge which acts as a watershed. Over this area there is an annual precipitation amounting in some parts to between 50 and 60 inches.

Lake Salisbury itself is drained into Lake Kioga by only one river, the Agu. The Agu is a broad swamp, but provides only two open-water drainage channels, somewhat below the general swamp level; so the waters of the lake, being confined, rapidly rise in level after heavy rain. The outlets of Lake Kioga also are narrow, and at times of heavy rainfall its water is backed up in the neighbouring swamps; the Kafu River reverses its direction of flow. The influence of this back flow, caused by the narrowness of the Victoria Nile at the Murchison Falls, may be felt as far to the east as the outlets of Lake Salisbury, which thus finds itself in the position that catchment waters are being

poured in on the one side, while on the other the natural outlets are stopped by the high water level in Lake Kioga. The water level of Lake Salisbury is thus doubly sensitive to increases of rainfall and varies considerably.

This rise and fall of the waters, which is both annual and periodical, influences, as might be expected, the ecology of the lake shore. Vegetationally, the area is highly specialized, and is unlike any other part of Uganda or even of Teso. There is a good deal of soil erosion, the Medical Department find nutritional deficiencies widespread amongst the inhabitants, and now we of the Veterinary Department find a syndrome in the cattle, which we attribute to insufficient mineral salts in the diet. The topographical factor is fundamental to an understanding of the position, and has been stressed for this reason.

OCCURRENCE OF THE DISEASE

The upland grass in the immediate vicinity of Lake Salisbury is of very poor quality; shortly after the cessation of the rains in December this has all been eaten and none remains even for burning. The cattle then graze daily on the flats along the lake shore from which the water has receded. The bulk of fodder is sufficient and the grasses present are good succulent types (see the appendix for an enumeration of grasses of both upland and lake shore types); nevertheless, whereas in the wet season the cattle thrive on the poor upland grasses, in the dry season they succumb to a disease similar to the *stywesiekte* described from South Africa.



It appears probable that the leaching of the soil due to alternate flooding and draining is responsible for the removal of some of the essential salts in solution, and that their absence, though not reflected in the vegetational picture, may yet have far-reaching results from the nutritional viewpoint. A little support for this view is forthcoming from the analysis (by Dr. G. Griffith, Chemist, of the Agricultural Department) of a single sample of swamp soil taken near Kapujan, where the disease is especially acute. It is the only sample that has so far been analysed, but is stated to be very low in both potash and phosphorus and low in calcium. The figures are said to compare unfavourably with other samples from Teso, both from swamp and upland.

CLINICAL SIGNS

Acute clinical signs are seen only in the dry season; they gradually disappear with the onset of the rains. The two photographs reproduced here show an example of an extreme case of the disease, which had failed to make a recovery when the upland grazing was again used. The following points should be noted:—

- (a) The general debilitated and shrunken appearance of the cow.
- (b) The crossing of the knee joints of the animal when standing. The abnormality of these joints gave rise to a jerky gait, since difficulty appeared to be encountered in flexing the knee in order to bring the leg forward. The condition appears to be due to a laxness of the ligaments. Similarly, at times, a turning outwards of the hind legs was also noticeable, which led to a crossing of the hocks.
- (c) The overgrowth of horn on both inner claws of the front legs. The natives stated that this was due to walking on the soft swamp ground in the dry weather, but the swamp ground in the dry weather is not

especially soft, and signs of a chronic laminitis are present.

- (d) General symptoms of pica are not marked, but the condition of calves is poor in spite of the relative scarcity of east coast fever in the area; the milk yield of the dams is probably affected.

ETIOLOGY

The clinical signs are those of *stywesiekte*. This may be due to one of two causes:—

- (a) Poisoning by *Crotalaria Burkeana*.¹
- (b) Insufficient phosphorus in the diet.

A number of *Crotalaria*s exist in the region, and for the present poisoning cannot be ruled out by one of these. Nevertheless, the *Crotalaria*s exist on the upland and not along the lake shore, so that symptoms of poisoning by them would be expected in the wet season and not in the dry. Further soil analyses will perhaps throw light on the condition, as to whether or not it is due to a lack of phosphorus, and possibly other salts, in the diet.

APPENDIX

A—LIST OF COMMON SWAMP GRASSES

Panicum repens L., *Sporobolus pyramidalis* Beauv., *Setaria sphacelata* (Schumacher) Stapf. and Hubbard, *Acroceras macrum*, *Bothriochloa insculpta* (Hochst.) A. Camus, *Eragrostis paniciformis* (A. Br.) Steud., *Themeda triandra* Forsk. var. *hispida* Stapf., *Echinocloa pyramidalis* (Lam.) Hitchc. and Chase, *Brachiaria fulva* Stapf., *Paspalum auriculatum* Presl.

B—LIST OF COMMON UPLAND GRASSES

Chloris gayana Kunth., *Eragrostis superba* Peyr., *E. chalcantha* (Kunth.) Trin., *Panicum maximum* Jacq., *Sporobolus festivus* Hochst., *Hyparrhenia dissoluta* (Steud.) Stapf., *Perotis indica* (L.) O. Kuntze, *Brachiaria brizantha* (Hochst.) Stapf., *Urochloa panicoides* Beauv., *Eragrostis tremula* Hochst., *Rynchelytrum repens* (Schumacher) C. E. Hubbard, *Heteropogon contortus* (L.) Beauv. ex R. and S.

¹ Mr. Greenway, Botanist at Amani, comments that this particular *Crotalaria* can be ruled out, as it has not been recorded north of the Transvaal; but that several other *Crotalaria*s have been suspected or recorded as causes of cattle disease.—Ed.

THE CONSTRUCTION OF A CATTLE CRUSH

By G. S. Cowin, M.R.C.V.S., Veterinary Department, Tanganyika Territory

Although the general principles for building a cattle crush are the same whether it is on a farm or elsewhere, nevertheless this article has special reference to large-scale inoculations in native areas.

Assuming that poles are easily obtainable, thirty labourers can complete a crush, suitable for inoculating 1,000 to 3,000 head of cattle, in three days.

Site.—A piece of fairly level, hard ground about 100 yards in length. The prevailing wind should blow from the crush end to the collecting-pen end, otherwise the workers become smothered in dust. If possible, the shade of a few large trees should fall on the inoculator's platform during the heat of the afternoon.

Materials Required.—About 450 poles each 5 ft. 6 in. long and about 50 poles each 12 ft. long. These poles should be two to three inches in diameter. About a dozen bundles of bark rope and twenty large bundles of long thin sticks. Large numbers of thorn branches or small thorn trees. About six bundles of tall grass.

Division of Labour.—About twenty of the thirty labourers will be occupied for two days in collecting the materials. Men cutting poles should be put on piecework, about 25 poles per man per diem being a fair allocation. On the third day everyone helps to erect the crush.

Marking Out.—About ten labourers with hoes and *pangas* are required, plus a supply of pegs and long thin rope. First peg a strip ABCD on the plan 40 yards long by 18 inches wide, and on each side of it dig a trench one foot deep and eight inches wide. Carry on the line AB from B to E a distance of nine yards and continue the trench outside it. At D make an angle of about 45 degrees, and peg from

D to F, a distance of about 12 yards; carry on the trench outside the line DF. Peg a line from F to E, but stop at G. (The space between G and E is the entrance to the inner collecting pen, and should be about two yards wide.) Continue the trench from F to G. From points E and F mark off a roughly circular *boma* about 30 yards in diameter.

Building.—Beginning at A or C, 20 men each take a pole, and standing in the passage-way AC, place the poles in the trench as close to the inner face of the trench as possible. The poles should be held with a slightly outward lean, so as to make the measurement across the top of the crush approximately two feet. The distance between every two poles should be about three inches; this is to allow easy passage to branding irons.

In the trench, outside the bottom of the firmly-held upright post, long straight poles are laid horizontally and maintained in position by wooden pegs driven into the floor of the trench. The upright poles at A, B, C and D should be 12-foot poles and similar poles should be used at about six-yard intervals along the lines AB and CD. These poles should be exactly opposite each other, and when tied across their tops they increase the rigidity of the whole structure.

It is important that the upright poles should be firmly held in position while the earth is filled into the trench and rammed tight. If the pegging of the poles and ramming of the earth is done properly, there is no fear of the crush bulging outwards, however wild the cattle may be.

Along the line BE and the triangle DFG only 12-foot upright poles should be used. Once in position they should be strongly bound together with horizontal

fito, because the inner collecting pen is subject to great strain.

On the section ABCD four horizontal parallel rows of *fito* should be used. The topmost row should be six inches from the top of the poles and the space between every two rows should be six inches. Thus the lower row of *fito* is 2 ft. 6 in. above the ground level and there is a space of one foot between it and the top of the inoculator's platform. (This space is to allow for branding.) The rows of *fito* should be firmly bound to the poles and to each other in order to prevent them from slipping downwards. Along the top of the poles on the section CD bundles of long grass about one foot in circumference are bound tightly, so that inoculators can lean over in comfort. It is a mistake to bind *fito* on the inner side of the poles in section ABCD because they are liable to catch horns and legs.

The inoculator's platform is made by driving strong pegs into the ground at a distance of 30 in. from the crush rails. The pegs should be 2 ft. 6 in. long and should be driven one foot deep into the ground. They are then bound together with *fito* closely enough to retain earth. Earth is then shovelled into the space between the pegs and the crush rails and trampled down to form a hard platform. It is advantageous, but not essential, to have a platform on each side of the crush.

The calf enclosure is made by fencing off a portion of the main collecting pen with a thorn fence. From this enclosure a V-shaped fence with sides about three yards long opens into the calf-crush. This crush should be about 15 yards long and the upright poles should not be more than 3 ft. 6 in. above ground level. It is unnecessary to trench and peg the uprights. The width of the calf-crush should be about 15 inches.

PRACTICAL HINTS ON USING THE CRUSH

1. To facilitate record-keeping it is best to drive a complete herd belonging to one village or one man (depending on circumstances) into the main collecting pen and then put all the calves in the calf-enclosure. Other herds graze outside until required.

2. The inner collecting pen (EBDFG) must always be kept absolutely full and cattle released from it while the last few animals of preceding crushful are going out, ensuring continuity and saving time.

3. The cattle should not be packed tightly in the crush until they have been branded, but once the branding is finished they should be packed as tightly as possible before inoculation commences. Gently twisting the tail is the best method of packing. A well-packed crush means time saved and less risk of damage to inoculators' hands and to syringes.

4. About 20 men, each with a pole, are required on the opposite side of the crush to the inoculators. Their job is to help to pack the crush and then to maintain the cattle in position by thrusting their poles through the crush rails. When an animal is particularly fractious a pole over its neck prevents it from horning the inoculator or trying to leap the crush rails.

5. A long strong rope should always be at hand in case an animal lies down. Much time can be wasted in trying to get it to its feet again, and it is far better to tuck its legs in comfortably and drag it out of the crush by means of a rope round its horns.

6. If an animal with abnormally long horns cannot pass through the crush, it should be roped by the horns in the inner collecting pen, dragged to crush entrance, branded, inoculated and released.

7. Never inoculate the calves until all the adults are finished; otherwise each owner departs with his herd and one is left with no assistants.



Entrance to main crush. One side is straight and continuous with side of crush to avoid jamming



Calf crush

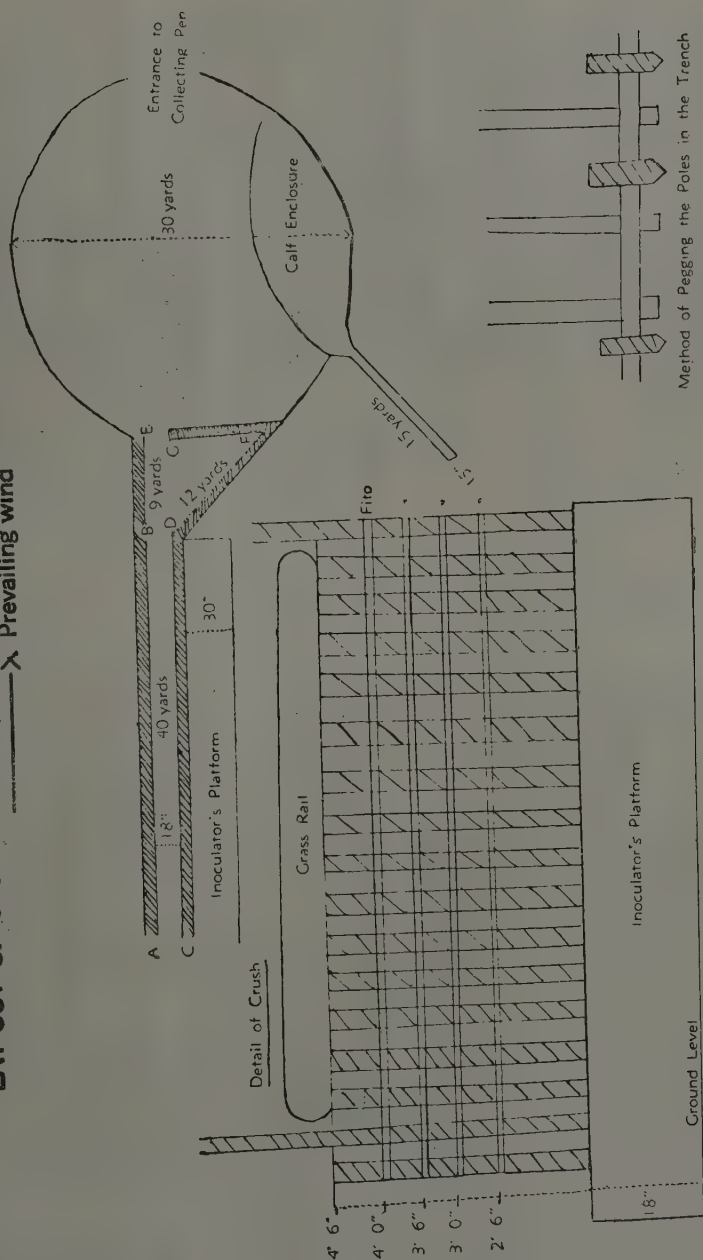


View from above crush exit. Shows calf pen jutting out from collecting *boma*.



Looking along crush. Shows high poles at intervals with cross-ties; inoculator's platform with binding to facilitate leaning over.

LAY-OUT OF CRUSH. Shaded portion is a trench 1 ft. deep and 8 in. wide.
 —X— Prevailing wind

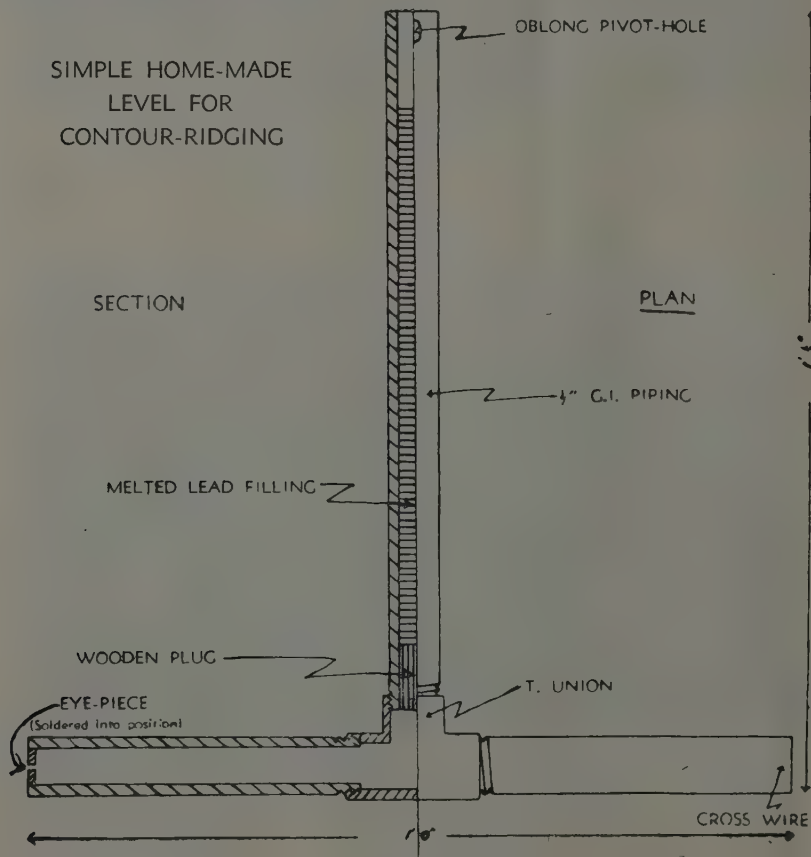


NOTES ON THE CONSTRUCTION OF A SIMPLE HOME-MADE LEVEL

By A. H. Savile, C.D.A., A.I.C.T.A., Agricultural Officer, Tanganyika Territory

"Walker" road tracers are comparatively expensive instruments, and boning rods, although cheap, are liable to produce startling results in contour lay-outs when handled by natives.

The attached drawing illustrates the structural details of a level which has been found to be well suited for use by African instructors. It is a modification of the "Walker" road tracer, and affords a cheap, strong, accurate and foolproof instrument for laying out the lines for contour banks. The level swings on a $\frac{1}{4}$ in. bolt placed about 3 in. from the top of a staff measuring 6 ft. x $1\frac{1}{4}$ in. x $1\frac{1}{4}$ in. A sighting staff with a 5 in. x 9 in. target, set at the same height as the sight line of the level, completes the outfit. It is an advantage if the target is quartered into black and white rectangles. The complete outfit can be made from scrap lengths of piping, etc., for approximately Sh. 3. A few points in regard to the construction of the level need explanation. The pivot hole is elongated slightly in order to permit the instrument to swing freely when the staff is not held vertically by the observer. The lead filling in the vertical arm is necessary in order to steady the level in windy weather and to assist in obtaining quick, accurate readings. The cross-wire should not be too fine—slightly thinner than an office pin is the best thickness. The level can be adjusted by screwing or unscrewing one or both of the sight tubes. Further adjustments can be effected by the application of a little solder.



REVIEWS

EXPERIMENTS IN COMPOST-MAKING:

R. Cecil Wood; *Emp. J. Exp. Agric.*, VI, 1938, pp. 350-368.

This is an account of a number of experiments carried out between 1932 and 1938 at the Imperial College of Tropical Agriculture at Trinidad. The nature of the problem—why one should use compost, its advantages, the advantages and disadvantages of alternative methods of increasing or maintaining soil humus—is first clearly stated. Detailed accounts of the various experiments follow. The results, although of course only strictly applicable to West Indian conditions, are instructive and deal with many points of interest to the practical compost maker. A final section brings together the experimental results, and in conclusion Professor Wood states:—

"1. It is not possible, even with standard material, to lay down a definite programme for composting.

"2. The time available for decomposition affects the methods adopted, as the more readily decomposition is wanted to occur, the more expensive the process becomes.

"3. Of the factors controlling decomposition, aeration and moisture are the most important.

"4. Correction for acidity has not been found necessary in the conditions obtaining.

"5. The use of inoculating material has not been found necessary unless very rapid decomposition is desired.

"6. By adopting a system similar to the Mauritian system, farm stock is most economically utilized for the decomposition of farm waste."

The Mauritian system consists essentially of putting the composting material under stock for a period, where it gets

trodden and bruised and at the same time receives the necessary inoculation, before building into heaps. This period, it is stated, need not be so long as is sometimes thought, and it is the practice on the college farm in Trinidad to change the material once a week.

One would endorse Prof. Wood's conclusions, especially as to the importance of correct air and moisture supplies, but it remains probable that the addition of lime or other basic material, such as rock phosphate, even if not specifically to correct acidity, will be a valuable feature of composting practice in most parts of East Africa.

W. E. C.

SOIL SURVEY (RECONNAISSANCE) OF ANTIGUA AND BARBUDA, LEEWARD ISLANDS, by C. F. Charter (Crown Agents, London, 1937; 2/-).

THE SUGAR CANE SOILS OF ANTIGUA, by F. Hardy, J. A. McDonald and G. Rodriguez (Government Printer, Trinidad, 1933; 1/-).

Antigua is one of the drier islands of the West Indies. The visitor making it his first port of call on the way from Europe finds it a good deal lacking in the tropic luxuriance he imagined awaited him in those parts. To one who knows *mbugas* in East Africa, the black-clay grasslands, in places dotted with very African-looking acacias, are unexpectedly familiar. So are the deforested, scrub-covered hills, some features of the peasant cultivations, and of course the features of the peasants themselves, mostly of African slave descent. The south-western third of the island (which measures altogether barely 12 by 10 miles) is too rough for much settlement, but 14,000 acres of a middle and eastern belt are under sugar cane.

The accounts of Antiguan soil conditions given in the two publications under notice are worth our attention because of the African resemblances. They are of interest, too, on more general grounds, as exemplifying modern methods of investigation applied to a complex of difficult soils on which an isolated population of 30,000 has to be fed, and on which an export agricultural industry has to maintain itself against world competition, under a climate none too favourable for the staple crop and yet without any aid from irrigation.

Professor Hardy's paper, No. 5 of his well-known *Studies in West Indian Soils*, issued from the Imperial College of Tropical Agriculture, has a background of residence in the island at an earlier period, but its immediate basis was a ten-days' period of intensive field work and the subsequent laboratory examination of some 420 samples, including 36 complete profiles. It is prefaced by an account of the geology and physiography, and develops a description of the soils grouped in the first place by parent materials and then re-grouped by the dominant physical and chemical characteristics of the profiles. Most of the soils are neutral or alkaline, some are highly calcareous and some are saline; nearly all are of poor natural drainage. There is a discussion of alkalinity and salinity in soils in general, and then of the Antiguan soils particularly in regard to these two properties as they affect drainage, permeability, droughtiness, root penetration and other matters of significance to the growth of cane. Phosphate deficiency is examined in the light of a biological (tomato seedling) test that has proved its value in Hardy's hands on other West Indian soils. Finally, some possibilities for amelioration are suggested, but it is emphasized

that much scope remains for fitting cane variety more exactly to soil type, to meet the exceptional conditions. (It is along this line at the present time that most progress is being made, apart from improvements in ordinary fertilizer practice.) In an appendix, the chemical and other laboratory data are set out in full in tables. It could be wished that in these tables the verbal descriptions of the horizons to which the numerical data relate were equally full, for they are too abbreviated to give always a clear picture of the profile.

The general impression conveyed is of a decidedly awkward lot of soils, most of them intractably heavy and running to chemical and physical extremes.

Mr. Charter's survey was inspired in the first place by his own enthusiasm as a field naturalist and was made possible as a systematic undertaking by the interest of one of the sugar companies. It is complementary to Hardy's, in that more stress is laid on soil morphology, soil types are separated out on this basis with more precision, there was leisure to map out the boundaries, and the whole island was included—not only the sugar lands. The American system of named "series" (e.g. Gunthorpe, Tyrrell, Delap) is adopted. Twenty-four such series are described in Antigua and four in Barbuda,¹ a neighbouring smaller island. Three of the Antigua series are illustrated by good photographs. The only grouping of the series is by parent materials into "suites," the basis of separation between some of which (Otto, Gunthorpe, and Fitches) seems to the reviewer to be somewhat arbitrary if judged by the lithological descriptions given.

The practical utility of christening soils like babies, as a recognition of their

¹ Two of the Barbuda soils (Barbuda and Codrington series) are recognizable as being closely allied to soils known in Zanzibar and on parts of the mainland coast of East Africa.

individuality, is now generally admitted. The names so devised, if decently euphonious (but should "Blubber Valley" have been immortalized?), readily find their way into local farming language. They are a help in advisory work, and facilitate the handling of land-utilization problems (e.g. the best use of new crop varieties) in terms of soil type. Mr. Charter's work covers Antigua with a mesh of soil information close enough to justify and to necessitate the introduction of this system, and he is to be congratulated on being able to take the step. It is a stage we shall be glad to reach more generally in East Africa, where at present the only customary use of such names is for certain rather broadly defined soil types in Kenya.

One is left wishing, however, that the new survey and its nomenclature had been better linked up with the careful work done under the auspices of the Imperial College only four years before. Charter's paper contains little of analytical data or discussions of fertility problems. These were Hardy's contribution, and as the localities of his samples were closely described and plotted on a sketch map, it should have been possible to identify the corresponding soils in terms of the newly established series names, so bringing forward the existing body of information for ready use. A correlation table performing this service would have been a valuable feature, which we miss. As it is, the only references to the earlier paper in the later one are critical, on certain points of disagreement, and the reader is made to feel an onlooker at a controversy instead of at an expanding body of knowledge. Soil survey activities in the British Empire are still few and unorganized; they are experimental, and there is room enough for differences of method and outlook. But it seems a pity that two such excellent examples (each in

its way) as these, on the same small island—and each published by official authority—should lack the co-ordination that would have given full value to the result.

G.M.

PASTURE RESEARCH IN SOUTH AFRICA:
PROGRESS REPORT No. 1; Government Printer, Pretoria, 1938; 162 pp., 38 photographs.

This is an interesting and valuable progress report (the first issued) of pasture investigations recently started under the ægis of the Plant Industry Division of the Union Department of Agriculture.

The work is the outcome of the gradual realization on the part of the administrator of the fact that a good plant cover is the best protection to catchment slopes and the only effective insurance against soil erosion. At the same time it is being increasingly realized that South Africa, a predominantly semi-arid country, is primarily suited to pastoral farming, and that pasture, whether natural (the veldt, as it is known there) or planted, will apparently always be the chief source of feed for the stock.

As stressed by J. W. Rowland in his introduction to the report, far too little is known about the correct management of the veldt:—

"A journey through the Union is sufficient to show what a terrible price is being paid by this and future generations of South Africans for this ignorance. We see whole districts which were recently ploughed for grain and which are to-day lying abandoned and are carrying ruderal and well-nigh useless vegetation. Throughout the Union the carrying capacity of the veldt is declining at an ever-increasing rate. Countless springs and streams which were perennial are to-day drying out. The desert is marching eastwards.

Karoo bush—the worst of it, unhappily—is intruding throughout the short grass country. Lastly, erosion, more spectacular, and possibly the more advanced stage of the other processes, is clutching at the rich soils of the Merino country.

“The needs of live stock in this country for supplementary feeds for fattening and for milk production have been ascertained; the production of these feedstuffs has also been investigated. What is happening to the bread-and-butter ration, the sole feed of the young and dry stock, and the cheap grazing for the Merinos? The veldt can no longer be regarded as a stable source of supply. It is moving downhill, trampled and pushed by the hoofs of tens of thousands of starving animals, loosened, and carried off by wind and water to the sea.

“Isolated cases of judicious management give indications of the enormous scope for improvement that does exist in the natural vegetation. To-day nobody is in a position to advise. Before any advice can be given, many factors require consideration.”

In 1934 the Union Parliament voted funds for a comprehensive programme of work under the direction of Dr. I. B. Pole-Evans, Chief of the Division of Plant Industry. Wisely he first instituted a general survey of the country preparatory to the selection of sites for a series of pasture research stations to cover the wide range of conditions prevailing in the Union. Six of these research stations have been opened and generously equipped. These are:—

(1) The Towoomba Pasture Research Station, near Warmbaths, in the Transvaal bushveldt or thorn country.

(2) The Athole Pasture Research Station, near Amsterdam, in the Transvaal tall grass country.

(3) The Leeuwkuil Pasture Research Station, near Vereeniging in the Transvaal and Free State mixed grass country, where the main problem is the restoration of good pasture conditions on worn-out maize lands.

(4) The Rietondale Pasture Research Station, Pretoria, in the mixed sourveldt of the Transvaal.

(5) The Estcourt Pasture Research Station, Estcourt, in the tall grass veldt of Natal.

(6) The Tabamhlope Pasture Research and Watershed Protection Station, on the foothills of the Drakensberg Mountains, and in typical mountain sour grass veldt, representative of the most mesophytic of conditions in South Africa and hence an important watershed area.

All these stations now have very complete programmes of work under way, of which details are given in the report under review. These cover a wide field, and include management, burning, hay-stacking, reclamation of eroded or depleted land, control of bush and weeds, and the breeding and establishment of superior pasture species.

The investigations are to a large extent exploratory, as needs be in so new a field, and a good deal of attention has been devoted to devising methods suitable for each set of the wide range of conditions. Brief mention is made of results obtained to date. Of particular interest is the success in the method of making hay from young veldtgrass by baling soon after cutting, and stacking under cover in such a way as to allow the hay to cure and complete the drying after baling.

To those interested in any of the many problems being studied, the report makes stimulating reading and affords useful guidance in the planning of work covered by the wide term “Pasture Research”.

R. R. S.



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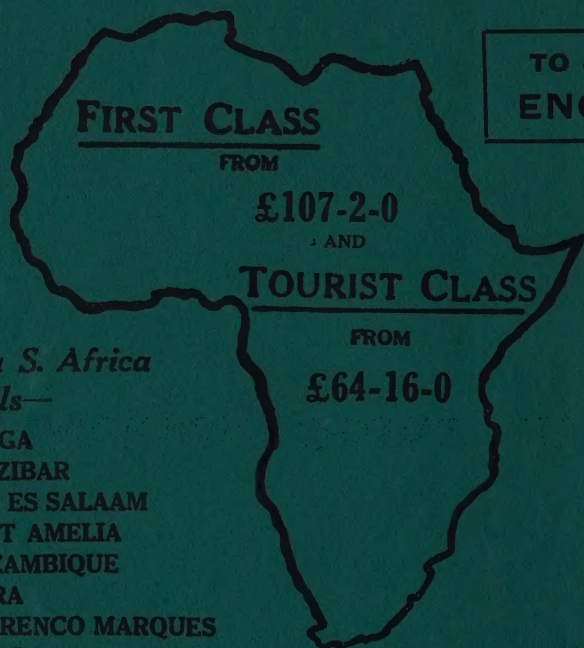
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